The global SEP landscape

Estimating SEP royalty flows into and out of Germany

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EXECUTIVE SUMMARY

To support policy makers in creating a policy environment that facilitates and encourages investment and innovation in Germany, we have been asked by the Fair Standards Alliance to develop a landscape of SEP royalty inflows and outflows for Germany, including any financial impact these royalties may have.

In order to do so, this report seeks to:

- Identify the largest SEP licensors worldwide and estimate the level of annual SEP licensing revenues accruing to these SEP holders; and
- Quantify SEP royalty flows into and out of Germany.

With regards to the global SEP licensing revenues, the main findings of our research are as follows:

We identify the largest individual SEP licensors and patent pools and provide estimates of their annual worldwide SEP licensing revenues (Section 2). A wide range of products, including consumer electronics devices, connected cars and increasingly the IoT, make use of technology standards (Section 2.1). Smartphones and connected cars take a particularly prominent role in the global SEP landscape as they jointly account for not only more than 1.5 billion sold units in 2022, but also involve cellular standards (such as 4G and 5G), the Wi-Fi standard, and video codecs such as AVC/H.264 and HEVC/H.265; which collectively are the royalty-bearing standards accounting for most of the estimated SEP royalties.

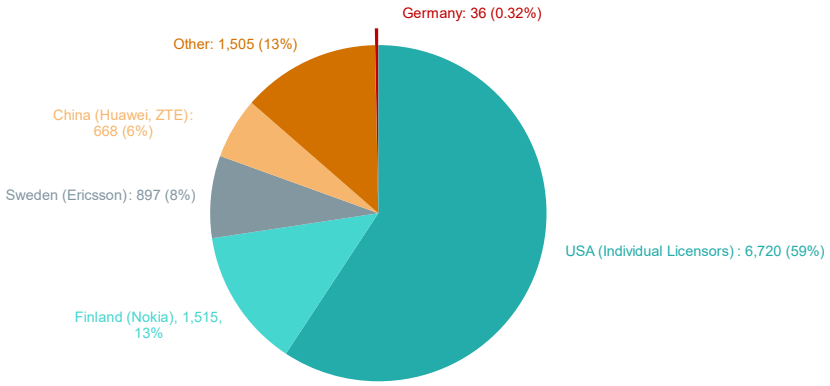
The annual global SEP licensing revenues of the largest individual SEP licensors and patent pools likely exceed EUR 11.3 **billion in 2022 (Section 2.2).** We have identified 17 SEP licensors that together account for SEP licensing revenues of EUR 10.3 billion in 2022. Since many SEP licensors do not disclose their licensing revenue, we have further estimated SEP licensing revenues for the most successful SEP patent pools to provide a more accurate picture of the global SEP licensing revenue. We estimate that those 7 patent pools earned around EUR 1.1 billion in annual SEP licensing revenues globally in 2022. When combining those licensing revenues, we account for the fact that some of the individual SEP licensors' revenue comes from their membership in patent pools.

As we focus exclusively on the largest SEP holders and patent pools with significant licensing revenue, we are likely to materially understate global SEP licensing revenues. While we identified more than 150 additional SEP licensors, due to the opaque SEP licensing landscape, we cannot reliably estimate their SEP licensing revenue. Our research should therefore be understood as a lower bound. Other studies estimate that SEP royalties in the mobile telecommunications industry amount to EUR 14-18 billion per year, with cross-licences generating another EUR 4 billion of non-monetary benefits.

SEP owners headquartered in Germany account for a negligible share of the annual global SEP licensing revenues (Section 2.3). As shown in the figure below, the combined share of SEP royalties for individual licensors from the US (in particular, Qualcomm), Sweden (Ericsson), Finland (Nokia) and China (Huawei, ZTE) amounts to 86% of total global SEP royalties in 2022. We estimate that only a tiny share of global SEP royalty revenue accrues to German SEP holders (Deutsche Telekom, Fraunhofer, Robert Bosch, Siemens and the non-practicing entity IPCOM). We estimate that Deutsche Telekom,

Robert Bosch, Fraunhofer, and Siemens generated only about EUR 36 million in SEP royalty revenue through their participation in patent pools, accounting for merely 0.3% of the global SEP royalties. While we could not find reliable information on further SEP licensing revenue from bilateral SEP licences of German SEP holders, it is unlikely that these would change the overall picture given the size of their respective SEP portfolios.

Share of SEP royalties by licensors' country of origin (2022, million EUR)



Source: CRA.

Note: "Other" includes individual licensors from other countries and patent pools' royalties excl. the royalties accruing to the identified German pool members.

Drawing on the estimated global SEP licensing revenues, we turn to quantifying royalty flows into and out of Germany (Section 3). SEP royalty flows take place at two different levels of the value chain: direct royalty flows at the technology level at which licensees (including component and end-device manufacturers) pay SEP royalties to SEP holders, and indirect royalty flows at the product level at which OEMs normally pass on SEP royalties at least to some extent to their customers in the form of higher prices.

This report focuses on inflows into and out of Germany, not on value flows within Germany (e.g., from companies headquartered in Germany to SEP holders in Germany or from customers in Germany to companies in Germany). Outflows and inflows at both levels are cumulative. For instance, companies headquartered in Germany pay royalties for licensed SEPs to foreign SEP holders and German customers additionally pay—in the form of higher product prices—for SEPs used in products by foreign companies that are sold in Germany.

With regards to the royalty flow into and out of Germany, the main findings of our research are as follows:

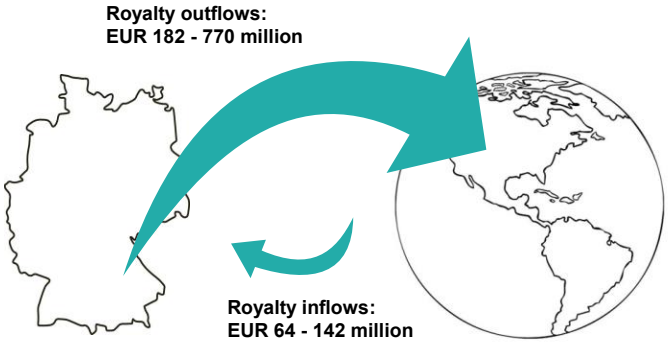
In assessing SEP royalty flows at the technology level (Section 3.1), we find that companies headquartered in Germany paid between EUR 93 and 148 million in SEP royalties to foreign SEP holders ("**direct royalty outflows**") in 2022. At the same time, foreign companies paid SEP royalties between EUR 33 and 52 million to German SEP licensors ("**direct royalty inflows**").

At the product level (Section 3.2), German customers bear between EUR 89 and 622 million of SEP royalties that are passed on by foreign OEMs ("**indirect royalty outflows**"), and foreign consumers pay between EUR 31 million and EUR 90 million of SEP royalties passed on by German OEMs to foreign consumers ("**indirect royalty inflows**").

Netting the royalty flows confirms that **Germany clearly is a net SEP licensee with a material net outflow of EUR** 117 **to** 628 **million in 2022.** With total royalty outflows

ranging between EUR 182 and 770 million in 2022, royalty flows out of Germany by far exceed total royalty inflows, which are in the range of EUR 64 and 142 million. These findings are driven by three key observations: (i) SEP owners headquartered in Germany hold a negligible share of the worldwide SEPs for the main standards, (ii) the share of global unit sales of products implementing the relevant standards to customers in Germany exceeds by far the share of SEPs held by German SEP holders, and (iii) recently, the SEP exposure of Germany has further increased with the advent of connected cars, which have resulted in additional royalty outflows from German car OEMs to foreign SEP owners via the Avanci patent pool.

SEP royalty flows into and out of Germany (2022)



Source: CRA.

1. INTRODUCTION

1. Technology standards are ubiquitous and ensure compatibility and interoperability of devices manufactured by different companies. The importance of technology standards cannot be overstated: electronical devices would not be able to communicate with one another without them. Among a plethora of technology standards, the most well-known are the cellular standards (e.g. 3G, 4G and 5G) and the Wi-Fi standards. Royalty-free and highly successful standards include Bluetooth, USB, and HTML.

2. Some of the standardized technologies are protected by patents. Once a patented technology is incorporated into a standard, the underlying patent is said to be a standard-essential patent ("**SEPs**"). A standard can involve hundreds or even thousands of individual patented technologies.

3. There have been few attempts to "map the SEP licensing landscape" from a more holistic perspective. This study constitutes an effort to shed some light on this issue by first assessing worldwide SEP royalty payments across licensors to then derive insights for royalty flows into and out of Germany.

4. The remainder of this study is structured as follows: Section 2 first provides a brief overview of the standard and device landscape and estimates global SEP licensing revenues in 2022. We estimate SEP royalty flows into and out of Germany in Section 3. Appendix A provides further details on the estimation of global SEP licensing revenues.

2. THE GLOBAL SEP LANDSCAPE

5. Companies contribute to the development of standards for different reasons. Companies contributing their technologies to royalty-bearing standards will often have an interest to monetise by licensing their technologies once the standard has been adopted. Well known examples include the cellular standards (2G, 3G, 4G, 5G), the Wi-Fi standards, as well as video codec standards such as AVC/H.264 and HEVC/H.265. We will see below that these standards also account for the vast majority of the estimated SEP licensing revenue. Cellular standards in particular have accounted for the bulk of all recent litigation cases,[1] underlining their preeminent role from a royalty perspective compared to other technology standards.

6. Patentees may alternatively commit to providing their patented technologies on a royalty-free basis, which allows interested companies to benefit from a very efficient use of the relevant standards in their products. Royalty-free standards can be very attractive for vertically integrated firms that monetize their products in adjacent markets (e.g. the royalty-free video codec AV1, developed by Google, Meta and Netflix, among many others). There are many extremely successful royalty-free standards, including Bluetooth, HTML and USB.

7. This study focuses on the quantification of revenues from the licensing of SEPs and therefore on royalty-bearing standards. In the following, we will first provide an overview of product categories that have accounted for the vast majority of SEP licensing revenues (Section 2.1). We will then estimate the global SEP royalties in 2022 (Section 2.2), before breaking down the SEP royalties by country of domicile for the SEP licensors (Section 2.3).

2.1. Product categories generating most of the SEP royalties

8. SEP licensing revenue primarily comes from the sale of smartphones, other consumer electronics devices and cars. The sale of devices connected to the Internet of Things ("**IoT**") will likely also generate significant SEP licensing revenues in the near future.

9. **Smartphones and other consumer electronics devices**. The consumer electronics device segment encompasses various product categories including mobile devices, personal computing devices, audio and video systems, and smart home technology. The licensing of devices in this segment accounts for the majority of global SEP licensing revenue.

10. Many consumer electronics products implement royalty-bearing standards. With 1.52 billion unit sales in 2022, smartphones play a particularly prominent role among those consumer electronics devices (see Figure 1 below). Apart from smartphones, consumer electronics devices such as tablets, TVs and other smart devices are likely among the products responsible for most SEP licensing revenue. In 2022, consumers bought 1.21 billion units of these devices.[2]

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1 Cellular standards have accounted for over 70% of all SEP litigation cases in the last two decades, see https://www.iplytics.com/wp-content/uploads/2021/03/SEP-Litigation-Trends-and-Licensing-Realities-IPWatchdog-and-IPlytics-March-2021.pdf.

2 See Figure 1 below for a complete list of devices types included.

11. Virtually all smartphones, tablets and TVs implement multiple royalty-bearing standards. For instance, smartphones rely on royalty-bearing standardised technologies such as cellular standards, Wi-Fi, and audio and video codecs. While TVs and many tablets do not have cellular connectivity, they do rely on video compression standards as well as Wi-Fi standards for short to medium range connectivity. While cellular standards, video codecs and Wi-Fi standards account for the bulk of the estimated SEP licensing revenue, many more standards are typically involved in consumer electronics products.

12. The number of royalty-bearing consumer electronics device sales will grow by around 2% annually to reach around 3.2 billion units sold globally in 2027.[3]

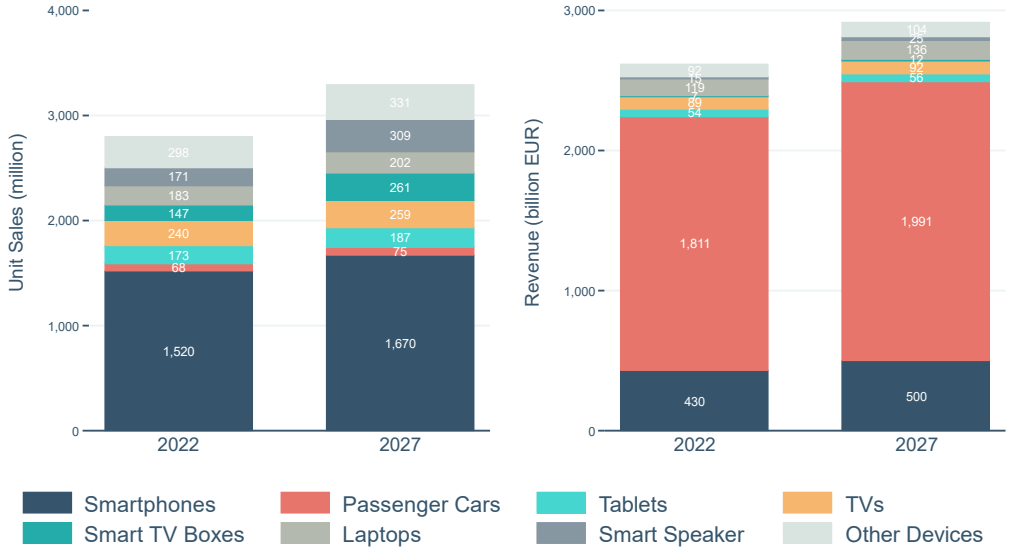
13. **Passenger cars**. Standardised technologies, in particular cellular standards, play an increasingly important role in passenger cars. This is evident from the fact that almost all major car OEMs have signed up for an Avanci licence to implement the 2G, 3G and 4G standards.

14. With 68 million cars sold, the global passenger car market is estimated to be worth around EUR 1.8 trillion in 2022. While it is estimated that the global passenger car market will grow only moderately to around 75 million annual car sales, it is estimated that the share of new vehicles shipped with built-in connectivity will increase from 48% in 2020 to 96% in 2030.[4]

3 Calculated as the weighted average cumulative annual growth rate from 2022 to 2027 for all device types included in Figure 1.

4 See Statista, *Share of new vehicles shipped worldwide with built-in connectivity in 2020 and 2030*, available at https://www.statista.com/statistics/1276018/share-of-connected-cars-in-total-new-car-sales-worldwide/ (last accessed 1 October 2023).

Figure 1: Projected global sales of selected consumer electronics devices and passenger cars



Source: CRA based on Statista, *Consumer Electronics – Worldwide*, available at https://www.statista.com/outlook/cmo/consumer-electronics/worldwide (last accessed 29 September 2023) and Statista, *Passenger Cars – Worldwide*, available at https://www.statista.com/outlook/mmo/passenger-cars/worldwide (last accessed 29 September 2023).

Notes: Category "Other Devices" includes Desktop PCs, digital cameras, drones, gaming consoles, smart remotes, VR headsets and video players.

15. **Internet of Things**. Furthermore, the number of royalty-bearing devices will likely grow significantly due to the emergence of the IoT. For instance, the total number of cellular IoT connections is predicted to grow by 21% per year from 1.2 billion in 2022 to 3.3 billion connections in 2027.[5]

16. In light of the growing number of royalty-bearing devices, SEP licensing revenues will likely grow significantly in the years to come.

2.2. Estimating global SEP royalties in 2022

17. The lack of transparency in the global SEP licensing landscape presents two key challenges in accurately estimating global SEP licensing revenues. The first challenge is identifying SEP holders that request SEP royalties from standard implementers. Having identified SEP holders with SEP licensing income, the second challenge is estimating the level of SEP licensing revenues for each of them.

18. To overcome these challenges, we use a bottom-up approach to estimate the level of global SEP royalties. We identify the largest SEP licensors and estimate their respective SEP licensing revenues for 2022. Our identification of SEP holders is limited to only those firms that are actively seeking licensing revenues for their SEPs. We exclude firms that primarily engage in cross licensing and those licensors that choose to not assert their patents.

5 Cellular IoT connections include 2G, 3G, 4G (including NB-IoT and LTE-M), 5G non-mMTC, and 5G mMTC. See Transforma Insights, September 22, 2023, Current IoT Forecast Highlights, available at https://transformainsights.com/research/forecast/highlights (last accessed 29 September 2023).

19. Many SEP holders that do not disclose their licensing revenues are members of patent pools. In order to at least partially account for their SEP licensing revenue, we estimate SEP licensing revenues of major licensing programs of patent pools. In contrast to individual SEP holders, patent pools typically publish not only their requested royalty rates but also a list of licensees. Combined with the licensees' sales volumes, we use this public information to estimate SEP licensing revenues of patent pools bottom-up.

20. Since some of the SEP licensors with documented licensing revenue are members of a patent pool, summing up the SEP licensing revenue of both individual licensors and patent pools would result in the double-counting of some SEP licensing revenue. For the purpose of estimating the total SEP royalty revenues, we avoid double counting by considering pool revenues only after removing the royalties earned by those SEP licensors individually identified.

21. Our research identified 17 individual SEP licensors with publicly available information on their licensing revenue. Section 2.2.1 presents the largest SEP holders and summarises our methodology used to estimate individual licensors' SEP revenues. Section 2.2.2 introduces the 7 licensing programs of patent pools that are in included in our estimation and the estimation methodology. Appendix A provides additional detail.

22. In Section 2.2.3 below, we combine the SEP licensing revenue of both individual licensors and patent pools and estimate that SEP holders globally earned at least EUR 11.3 billion in SEP licensing revenues in 2022. Of these, individual SEP licensors account for a total of around EUR 10.3 billion in SEP royalties globally in 2022. Pools earned a total of around EUR 1.3 billion in SEP royalties in 2022 (EUR 1.1 billion after excluding the SEP licensing revenue accruing to the 17 individual licensors).[6]

2.2.1. Individual SEP licensors with documented licensing revenue

23. For estimating the global SEP licensing revenue bottom-up, we first identify large SEP licensors with publicly available information about their licensing revenues ("documented" licensing revenue e.g. in annual reports).[7] Our research identifies 15 such individual SEP licensors. For 2 smaller SEP licensors (Tivo and Conversant IP) we did not find documented licensing revenue for recent years and extrapolated the SEP licensing revenue from the 2016 estimates of Galetovic et al. (2018). In total, SEP licensors with documented licensing revenue earned EUR 10.3 billion in SEP licensing revenue (of which we estimate EUR 8.5 billion are related to smartphones and EUR 1.8 billion are related to other products). In many cases however the documented licensing revenue refers not to the SEP licensing specifically but more generally to the companies' overall licensing revenue. To estimate the SEP licensing revenues for 2022, we estimate for each company the likely share of licensing revenue that is due to SEP licensing.

24. Appendix A presents these assumptions for each SEP licensor.

25. Figure 2 below shows that the distribution of SEP royalties is heavily skewed towards a small number of SEP holders. The SEP licensor with the most SEP licensing revenue in 2022 is Qualcomm, which generated EUR 5.7 billion alone. Qualcomm primarily develops

6 For further details, see a detailed methodology description in Appendix A.

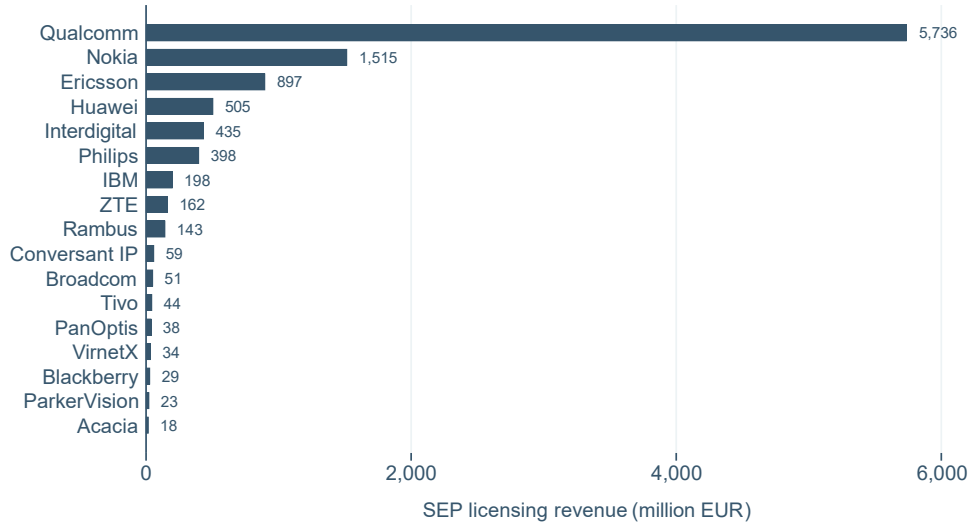
7 As a starting point, we consider smartphone licensors identified in Galetovic, Alexander, Stephen Haber, and Lew Zaretzki (2018), An estimate of the average cumulative royalty yield in the world mobile phone industry: Theory, measurement and results, *Telecommunications Policy* 42, no. 3 (2018), pp. 263-276.

semiconductors and is frequently named as one of the world's leading intellectual property owners for cellular standards including 3G, 4G and 5G. Nokia and Ericsson are the distant runners-up, with EUR 1.5 billion and EUR 0.9 billion in SEP licensing revenue respectively. Nokia and Ericsson both have large patent portfolios covering cellular standards and other technologies. Our SEP licensing landscape includes 14 additional individual SEP licensors with documented licensing revenue of more than EUR 10 million in 2022.

26. The skewed distribution of SEP licensing revenues towards a small number of SEP holders implies that a few countries account for the vast majority of global SEP licensing revenue. US based companies are clearly leading the field in terms of SEP royalties, with Scandinavia (Nokia, Ericsson) and China (Huawei) being distant runners-up. None of the 17 largest individual licensors are headquartered in Germany.

27. Germany's position in the global SEP landscape is discussed in Section 2.3 below.

Figure 2: Estimated SEP licensing revenues of the largest identified individual SEP licensors (2022)



Source: CRA.

Notes: Appendix A describes for each SEP licensor the methodology used to derive global SEP licensing revenues.

2.2.2. Patent pools with significant licensing revenue

28. By estimating SEP licensing revenues only for licensors with documented licensing revenue, we likely understate global SEP licensing revenue significantly. As many SEP holders that do not disclose their licensing revenues are members of patent pools, we can account for at least some fraction of their SEP licensing revenue by estimating SEP licensing revenues of these patent pools.

29. While estimating SEP licensing revenue for patent pools, it is important to note that patent pool members typically also conclude bilateral licensing agreements outside of pools, and this falls outside of our estimation because we cannot estimate the SEP licensing revenues of bilateral licensing agreements.

30. There exist a multitude of patent pools offering SEP licence programs for many different standards. However, pools greatly vary in the number of licensees they manage to attract. We identified 7 major patent pool licensing programs for which we estimate SEP licensing

revenues, namely Avanci (4G Vehicles), Access Advance (HEVC), MPEG LA (AVC, HEVC and MPEG-4) and Via Licensing (AAC, WCDMA).[8]

31. For the purposes of this study, we estimated the licensing revenues of the Avanci 4G Vehicles, Via Licensing AAC and MPEG LA MPEG-4 pools "bottom-up", based on the licensed volumes and the patent pools' respective royalty rates. A bottom-up estimation is possible because in contrast to individual SEP holders, patent pools typically disclose both licensees and headline royalty rates. Combining this with the licensees' estimated sales volumes allows us to approximate the pools' total licensing revenues.[9] For the Access Advance HEVC, MPEG LA HEVC and MPEG LA AVC pool programs, drawing on third-party estimates, we estimate the total SEP licensing revenue top-down. That is, we first estimate the total licensing revenue for the standard and then distribute that licensing revenue among the various patent pools.[10]

32. Some of the individual SEP licensors with documented licensing revenue also license their SEPs through patent pools. For those firms, our estimated SEP licensing revenues already include their income from pool licences. Summing up the SEP licensing revenue of both individual licensors and patent pools would therefore result in the double-counting of some SEP licensing revenue. We avoid this double counting by removing all SEP licensing revenues accruing to the 17 individual SEP holders from the total pool licensing revenue. As we explain for each patent pool in more detail in Appendix A, we do so by allocating the total SEP licensing revenue across the various licensors proportional to their patent share.[11]

33. Following this methodology, our estimate that the 7 major patent pool programs earned a total of EUR 1.3 billion in SEP licensing revenues in 2022. The Avanci 4G Vehicle licensing pool earned the highest licensing revenues (EUR 488 million) in 2022 and accounts for up to 36% of the total SEP licensing revenue that patent pools in our SEP landscape collect. The runners-up are Access Advance (HEVC) with EUR 268 million in SEP licensing revenue, MPEG LA (AVC) with EUR 228 million and Via Licensing (AAC) with EUR 201 million in 2022. MPEG LA (HEVC), Via Licensing (WCDMA) and MPEG LA (MPEG-4) individually earned less than EUR 100 million in SEP licensing revenues in 2022.

34. When removing all SEP licensing revenues accruing to the 17 individual SEP holders, the 7 selected patent pools earned a total of EUR 1.1 billion in SEP licensing revenues in 2022

8 Due to the lack of sufficient information, the bottom-up approach could not be applied to the Via Licensing WCDMA pool for which the estimate is based on an extrapolation of Galetovic et. al.'s estimate for 2016.

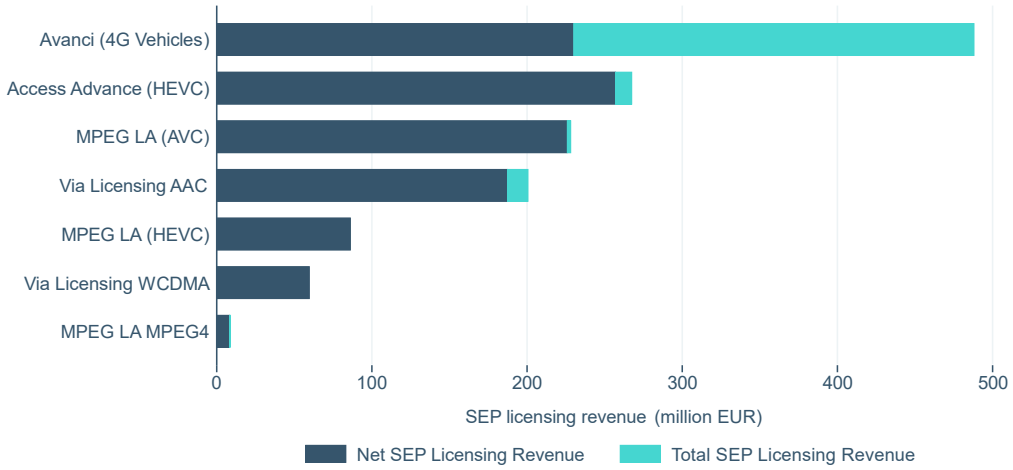
9 This approach implies that we estimate a patent pools' annual running royalty income and disregard any royalty payments for past years' sales.

10 Due to the lack of sufficient information, neither a bottom-up nor top-down approach could not be applied to the Via Licensing WCDMA pool for which the estimate is based on an extrapolation of Galetovic et. al.'s estimate for 2016.

11 Removing the revenue in proportion to patent shares means that we effectively also remove any patent pool fees charged on SEP royalties accruing to individual SEP holders. This is conservative as individual SEP holders may record net licensing revenue received from pools after deducting pool fees, whereas licensees are typically required to pay the full royalties, a portion of which is then retained by pools to cover their fees.
In cases where the patent share is not publicly available (e.g. for AVC and HEVC), we distribute the revenues equally among licensors.

(of which EUR 0.4 billion is related to smartphone sales and EUR 0.7 billion is related to other products such as cars).

Figure 3: Estimated SEP licensing revenues of major patent pool programs (2022)



Source: CRA.

Notes: For further details, Appendix A describes for each patent pool the methodology we use to derive both total SEP licensing revenues and net SEP licensing revenues (excluding SEP licensing revenue accruing to individual SEP licensors). In May 2023, the Via Licensing and MPEG LA pools formed Via Licensing Alliance.

35. The Avanci patent pool stands out not only due to its high SEP licensing revenue but also due to its recent success in licensing most of the global car OEMs. As of July 2023, the Avanci 4G Vehicles pool covers 56 licensors, including many of the largest cellular SEP holders such as Qualcomm, Ericsson, Nokia, and LG.[12] The success of Avanci in licensing car OEMs was preceded by extensive litigation whereby various members of the pool sought injunctions against car OEMs such as Mercedes and Ford.[13]

36. As detailed in Appendix A, we estimate that Avanci licensees sold around 34 million connected vehicles in 2022. In comparison, the Avanci pool itself announced in September 2022 that it had licensed more than 100 million connected vehicles to date.[14] By August 2023, Avanci announced that 130 million connected vehicles were covered by an Avanci 4G licence.[15]

12 See Avanci, *Licensors on the Avanci Vehicle 4G platform*, available at https://www.avanci.com/vehicle/4g/ (last accessed 07 July 2023).

13 See, for instance, Juve Patent, May 2022, *Ford takes Avanci licence in wake of Munich judgment*, available at https://www.juve-patent.com/people-and-business/ford-takes-avanci-licence-in-wake-of-munich-judgment/ (last accessed 2 October 2023) and Juve Patent, April 2021, *Conversant and Daimler end connected cars dispute*, available at https://www.juve-patent.com/cases/conversant-and-daimler-end-connected-cars-dispute/ (last accessed 2 October 2023).

14 See Avanci, September 2022, *Avanci Expands 4G Coverage to Over 80 Auto Brands*, available at https://www.avanci.com/2022/09/21/avanci-expands-4g-coverage-to-over-80-auto-brands/ (last accessed 26 September 2023).

15 See Avanci, August 2023, *Avanci Launches 5G Connected Vehicle Licensing Program*, available at https://www.avanci.com/2023/08/16/avanci-launches-5g-connected-vehicle-licensing-program/ (last accessed 26 September 2023).

37. Avanci's current licensing rate for 4G (including 2G, 3G and e-call) is set at USD 20 per vehicle for licensees that joined the pool after 1 September 2022. This rate was increased by more than 30% from previously USD 15 for licensees that joined before.[16] For 3G (including 2G and eCall) and eCall only, Avanci charges USD 9 and USD 3 per vehicle, respectively.

38. For the calculation of SEP licensing revenues in 2022, we conservatively assume that Avanci offers all licensees that joined the Avanci 4G Vehicles pool in 2022 a running royalty rate of USD 15 for 4G-enabled cars. We estimate that Avanci generated around EUR 488 million in licensing revenue in 2022,[17] as further detailed in Appendix A.

39. The SEP licensing revenue of the Avanci pool is likely to increase significantly in the years to come. As shown in Figure 1 above, analysts forecast that around 75 million cars will be sold in 2027. Assuming that 80% of those cars will be 4G-enabled,[18] Avanci and its licensors stand to make at least EUR 0.9 billion in annual SEP royalties in 2027.[19] If those cars were 5G-enabled, Avanci would generate annual SEP licensing revenues close to EUR 1.7 billion, assuming Avanci is successful in licensing car OEMs to their recently launched 5G Vehicles pool.[20]

2.2.3. Global SEP licensing revenue in 2022

40. Taking the SEP licensing revenue of both individual licensors and patent pools, we estimate that SEP holders globally earned at least EUR 11.3 billion in SEP licensing revenues in 2022, as summarized in Table 1 below. Individual licensors with documented licensing revenue earned a total of around EUR 10.3 billion. After removing the SEP licensing revenue of patent pools accruing to the 17 individual licensors, patent pools generated additional SEP licensing revenues of EUR 1.1 billion.

41. While patent pools play an important role for the licensing of specific standards (e.g. 2G, 3G and 4G for which many SEPs are licensed through the Avanci pool; or the video codec standard AVC for which the majority of SEPs are licensed through the MPEG-LA patent

16 On 16 August 2023, *Avanci launched its Avanci 5G Vehicle platform* (see https://www.avanci.com/vehicle/5gvehicle/) covering 58 licensors and charging a base running royalty rate of USD 32 per vehicle (USD 29 per vehicle for early licensees). The 5G rates has therefore increased significantly compared to the current 4G rate of USD 20.

17 We estimate that in 2022 licensees of the Avanci pool sold 34 million 4G-enabled cars. For each of those cars, Avanci received a royalty of USD 15.

18 See Statista, *Share of new vehicles shipped worldwide with built-in connectivity in 2020 and 2030*, available at https://www.statista.com/statistics/1276018/share-of-connected-cars-in-total-new-car-sales-worldwide/ (last accessed 1 October 2023). It is estimated that the share of new vehicles shipped with built-in connectivity increases from 48% in 2020 to 96% in 2030. Assuming linear growth, the share of connected vehicles will be around 82% in 2027.

19 Calculated as follows (before converting to EUR): 75 million cars × 80% 4G-enabled cars × USD 15 royalty rate per vehicle.

20 Calculated as follows (before converting to EUR): 75 million cars × 80% 4G-enabled cars × USD 29 royalty rate per vehicle. The assumption of USD 29 is conservative and the annual licensing revenues will be higher to the extent auto OEMs sign up after 2023.

pool), their share of overall SEP royalties amounts to only around 9% and is thus rather limited.[21]

Table 1: SEP licensing revenues by licensor in 2022

Licensor (country of domicile)	Methodology	SEP Licensing Revenue (million EUR)	
Individual licensors with documented licensing revenue			
Qualcomm (USA)	Documented		5,736
Nokia (Finland)	Documented		1,515
Ericsson (Sweden)	Documented		897
Huawei (China)	Documented		505
Interdigital (USA)	Documented		435
Philips (Netherlands)	Documented		398
IBM (USA)	Documented		198
ZTE (China)	Documented		162
Rambus (USA)	Documented		143
Conversant IP (Canada)	Documented*		59
Broadcom (USA)	Documented		51
Tivo (USA)	Documented*		44
PanOptis (USA)	Documented		38
VirnetX (USA)	Documented		34
Blackberry (Canada)	Documented		29
ParkerVision (USA)	Documented		23
Acacia (USA)	Documented		18
SEP licensing revenue of individual licensors			10,286
Patent pools with significant licensing revenue		Total	Net
Avanci (4G Vehicle)	Calculated	488	230
Access Advance (HEVC)	Calculated	268	257
MPEG LA (AVC)	Calculated	228	226
Via Licensing (AAC)	Calculated	201	187
MPEG LA (HEVC)	Calculated	86	86
Via Licensing (WCDMA)	Extrapolated	60	60
MPEG LA (MPEG-4)	Calculated	9	8
Total licensing revenue of patent pools		1,340	1,055
Total licensing revenue			**11,340**

Source: CRA.

Notes: For further details, see methodology described in Appendix A. *: SEP licensing revenues extrapolated, based on documented licensing revenues in 2016 (as provided in Galetovic et al. (2018)).

21 This share corresponds to the patent pools' revenues without the revenues accruing to pool licensors whose SEP licensing revenue is already included in the documented licensing revenues in Section 2.2.1. See detail in Appendix A.

42. As we focus exclusively on the largest SEP holders with publicly available information on licensing revenue and patent pools with significant licensing revenue, we are likely to materially understate global SEP licensing revenues.

43. We are aware of several more owners of major SEP portfolios whose income from SEP licensing we could not include as neither licensing revenues nor royalty rates or licensees are publicly disclosed. While for some of those SEP holders we capture SEP licensing revenues at least partially through the estimation of SEP revenues of selected patent pools, there are many other SEP holders – including so-called non-practising entities ("**NPEs**") – that together likely generate sizeable SEP licensing revenues. NPEs often request significantly higher royalty rates than practising licensors. For instance, a recent study found that "*the median implied per patent family privateer ask rates are approximately 15 times higher than the median implied per patent family non-privateer ask rates.*"[22]

44. SEP holders whose licensing revenue we capture only partially (through their SEP licensing revenue from pools) or not at all include Crystal Clear Codec, Datang Telecom, Deutsche Telekom, ETRI, FG Innovation Company, Fraunhofer, Intellectual Ventures, IPCOM, LGE, NEC, NTT, Palmira, Panasonic, Quarterhill, Sharp, Robert Bosch, Siemens, Sisvel, Sony, Sun Patent Trust, VoiceAge EVS and Wi-Fi One**.** We note that some of these (e.g. LGE or Panasonic) have sizable SEP portfolios and/or have been recently involved in SEP litigation, which underlines their ambition to conclude further SEP licensing agreements and increase their SEP licensing revenue.[23]

45. Furthermore, some vertically integrated SEP holders whose primary business is the manufacturing of smartphones and other consumer electronics devices choose to cross license their SEPs in order to minimise the royalties they have to pay rather than generate SEP royalty income (e.g. Apple, Alphabet/Google, Intel, Samsung, Vivo, OPPO, Xiaomi, Lenovo). As previously mentioned, we do not quantify the value of cross licences.

46. Other studies estimate that SEP royalties in the mobile telecommunications industry amount to EUR 14-18 billion per year, with cross-licences generating another EUR 4 billion of non-monetary benefits.[24] This suggests that we understate global SEP licensing revenue in 2022 (excluding the value from cross licensing) by as much as 59%.

2.3. SEP royalties in 2022 by licensors' country of domicile

47. The estimation of royalty flows, as done in the next section, requires verifying each SEP licensor's country of domicile. None of the largest 17 individual licensors (as shown in Figure 1) are headquartered in Germany, with the majority of these firms coming from the US, and the remaining firms coming from Finland, Sweden, China, the Netherlands and Canada.

22 Stout, 2022, 2022 SEP Privateer Report, available at https://www.stout.com/-/media/pdf/2022_stout-sep-privateer-report.pdf.

23 For instance, see https://www.iam-media.com/article/exclusive-lg-electronics-sues-vivo-in-india-in-4g-5g-sep-spat or https://www.juve-patent.com/cases/panasonic-and-kather-augenstein-launch-first-major-sep-campaign-at-upc-against-oppo-and-xiaomi/.

24 Cited in European Commission (27 April 2023), Impact Assessment Report, accompanying the document Proposal for a Regulation of the European Parliament and of the Council on standard essential patents and amending Regulation (EU) 2017/1001.

48. While none of the individual SEP licensors with documented licensing revenues are German firms, we identified several firms headquartered in Germany that license their SEPs through patent pools for which we estimated SEP royalties:[25]

- Siemens is a member of the Avanci 4G, MPEG LA MPEG-4, MPEG LA AVC, Via Licensing WCDMA and MPEG LA HEVC pools;
- Fraunhofer is a member of the Avanci 4G, MPEG LA AVC, Sisvel Wi-Fi and HEVC Advance pools;
- Deutsche Telekom is a member of the Avanci 4G pool; and
- Robert Bosch is a member of the MPEG LA MPEG-4 and MPEG LA AVC pools.

49. We estimate the total SEP royalties accruing to those German SEP licensors by assuming that the respective patent pools' smartphone and non-smartphone royalties are paid out to their members in proportion to the members' share of SEPs included in the pool. German SEP licensors account jointly for around 1.4% of SEPs in the Avanci pool,[26] 4.2% of SEPs in the MPEG LA AVC pool, 2.9% of SEPs in the MPEG LA MPEG-4 pool, 0.2% of SEPs in the MPEG LA HEVC pool, less than 0.1% of SEPs in the Access Advance HEVC pool and 31.8% of SEPs in the Via Licensing WCDMA pool.[27]

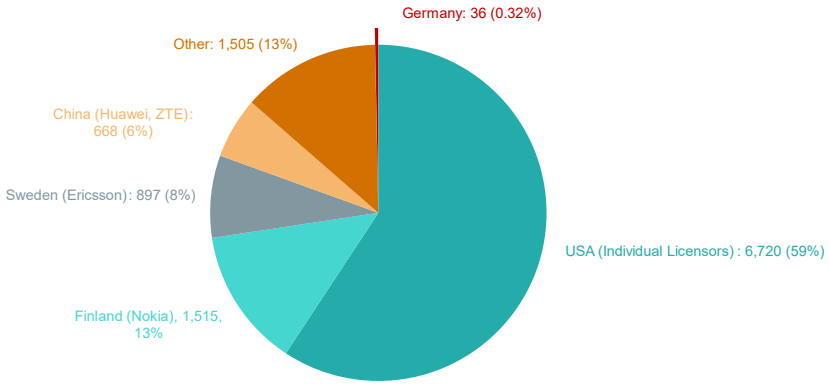
50. Taken together, we estimate that those four German SEP licensors generated SEP royalties amounting to around EUR 36 million in 2022, accounting for merely 0.3% of global SEP royalties. The vast majority of SEP licensing revenue therefore accrues to foreign SEP holders. As becomes clear from Figure 4, almost 90% of SEP revenues accrue to SEP holders in the US (in particular, Qualcomm), Sweden (Ericsson), Finland (Nokia) and China (Huawei) alone. In other words, given that almost all SEP holders are based in foreign countries, almost all SEP royalties paid by German OEMs result in royalty outflows to foreign SEP holders.

25 We cannot exclude that there are further smaller German licensors which have not been identified. However, based on the publicly available information it appears unlikely that there is any unidentified *major* SEP licensor headquartered in Germany. Royalties accruing to German licensors are therefore unlikely to be significantly underestimated.

26 Based on INPADOC families, and calculated using IPlytics data on all 4G SEPs (excluding WO and IB patents). Families are assigned to the ultimate owner, as defined by IPlytics.

27 There is no German SEP licensor in the MPEG LA HEVC pool.

Figure 4: Share of SEP royalties by licensors' country of origin (2022, million EUR)



Source: CRA.

Note: "Other" includes individual licensors from other countries and patent pools' royalties excl. the royalties accruing to the identified German members.

51. As mentioned above, we likely understate global SEP licensing revenue by as much as 59% due to the opaque SEP landscape. As can be seen in Table 2 below, we identified at least 150 additional SEP licensors for which we cannot reliably estimate the SEP licensing revenue. The majority of those licensors are located outside of the EU, with only 22 licensors being EU based. We are also aware of one additional German SEP licensor, IPCOM, with likely negligible SEP licensing revenue. Germany's actual share of global SEP licensing revenue is therefore likely even lower than the 0.3% shown in Table 5 above.

Table 2: Additional SEP licensors by country of domicile

Country of domicile	Number of additional SEP licensors
United States	48
South Korea	29
Japan	21
China	19
France	6
United Kingdom	5
Luxembourg	5
Germany	5
Taiwan	3
Canada	3
Netherlands	3
Sweden	2
India	2
Cyprus	1
Italy	1
Switzerland	1
Spain	1
Norway	1
Turkey	1
Belgium	1
Poland	1
Total	**159**

Source: CRA.

Notes: Based on desk research and licensors of the following patent pools: Access Advance (HEVC, VVC), Avanci (4G Vehicles), MPEG LA (AVC, EV Charging, HEVC, MPEG4, QI Wireless, VVC), Sisvel (5G MM, Wi-Fi, LTE 5GMM, LTE-M, WIFI, Wi-Fi 6), Vectis (Wi-Fi), Velos Media (HEVC) and Via Licensing (AAC, LTE, WCDMA). Excluding all individual SEP holders with documented licensing revenue. The five identified German SEP licensors are Deutsche Telekom, Robert Bosch, Siemens, Fraunhofer and IPCOM.

3. VALUE FLOWS INTO AND OUT OF GERMANY ASSOCIATED WITH SEP ROYALTIES

52. This section turns to Germany's position within the global SEP licensing landscape. With a view to assessing whether Germany is a net receiver or net payer of SEP royalties, we draw on the estimated global SEP licensing revenues to quantify royalty flows into and out of Germany.

53. In assessing the flows of SEP royalty payments and how Germany is affected, we can generally distinguish between three different groups of actors:

- **SEP holders** who receive SEP royalty payments from OEMs
- **OEMs** who pay SEP royalties to SEP holders and sell products either directly or indirectly to end customers; and

- **End consumers** who are indirectly affected by SEP royalties to the extent that OEMs pass-on some of the cost.

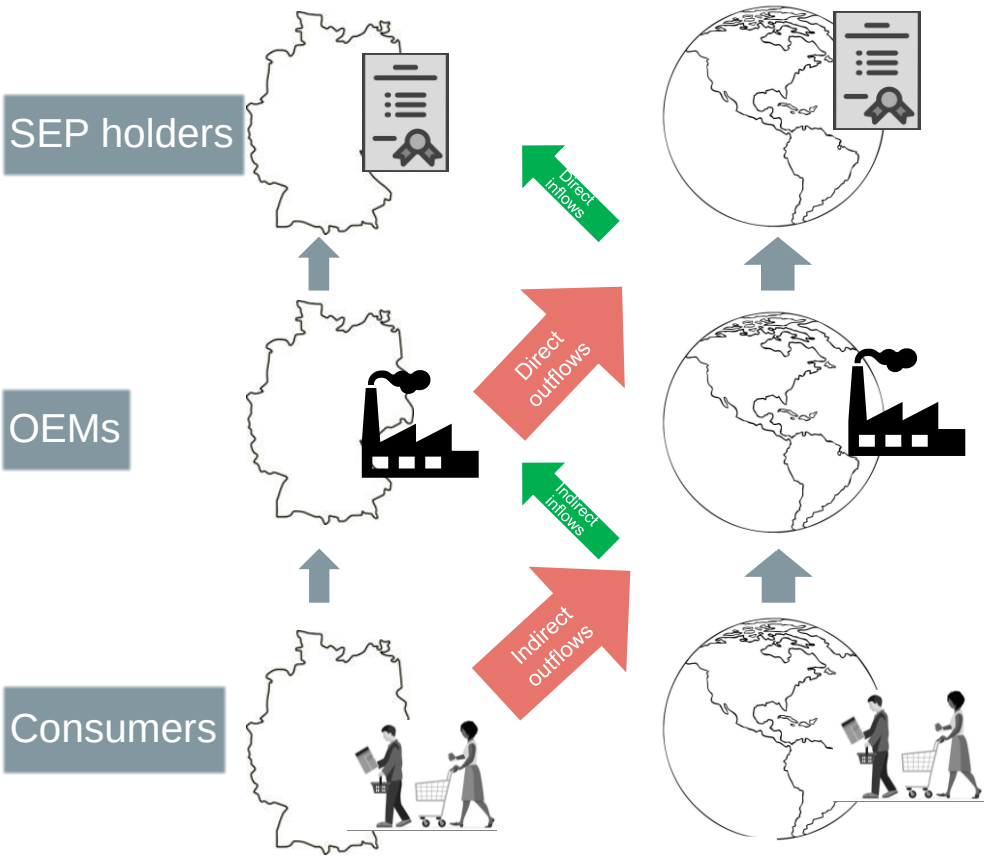
54. Value flows that are associated with SEP royalties and that take place between SEP holders, OEMs and consumers occur at two different levels in the value chain: on technology markets and further downstream on the markets for the products implementing the patented technologies (see Figure 2 below).

- **Technology level**. SEP royalties are paid directly by manufacturers (irrespective of the level in the value chain) to SEP holders (including pools).[28] We refer to royalty payments by firms headquartered in Germany to foreign SEP holders as ***direct* royalty outflows** (as shown by the red arrow in Figure 5).
  Conversely, a share of the SEP royalties paid by foreign manufacturers accrues to Germany-headquartered SEP licensors. Regardless of whether these royalties are triggered by sales inside or outside Germany, we refer to these payments to Germany-headquartered SEP licensors as ***direct* royalty inflows** as they flow from foreign firms into Germany (as shown by the green arrow in Figure 5).
- **Product level**. The royalty payment is typically associated with sales by an OEM to consumers.[29] At the product market level, consumers are affected by SEP royalty payments when German and foreign OEMs pass on the royalties charged by SEP holders to consumers in the form of higher prices. Therefore, German consumers carry a share of the royalty burden.
  In the following, we refer to SEP royalties that are passed on by foreign OEMs to German consumers as ***indirect* royalty outflows** (as shown by the red arrow in Figure 5). Indirect royalty outflows are separate from direct royalty outflows. While direct royalty outflows refer to royalties paid by German manufacturers to foreign SEP holders, indirect royalty outflows result solely from German consumers paying inflated prices to foreign OEMs.
  Conversely, ***indirect* royalty inflows** result from German manufacturers passing on a share of the SEP royalties to foreign customers in the form of higher product prices (as shown by the green arrow in Figure 5). Again, indirect royalty inflows are separate from direct royalty inflows. Direct royalty inflows refer to royalties paid by foreign OEMs to German SEP holders, whereas indirect royalty inflows result solely from German OEMs charging inflated prices to foreign consumers.
  If German manufacturers pass on royalty payments to German consumers in the form of higher product prices (see grey arrow in Figure 5), this shifts the royalty burden from the firm to its customers, but does not give rise to any additional royalty inflows or outflows.

28 We assume in the following that all royalties are paid by OEMs. This assumption is reasonable since cellular SEPs are typically licensed at the device level and account for the majority of SEP royalties.

29 If the SEP licensing occurs at the component level, SEP royalties are still associated with end-product sales, as the demand for the end-products typically drives the demand for the components.

Figure 5: Illustration of German royalty inflows and outflows



Source: CRA illustration.

55. In the following, we quantify direct and indirect royalty inflows and outflows based on our identification of the main SEP licensors and their SEP royalties in Section 2 above. In estimating the royalty flows, it is important to note that our estimations are subject to material uncertainty. We therefore estimate lower bounds based on the SEP landscaping in Section 2 and upper bounds reflecting the fact that there are SEP royalty payments that are not captured by our landscaping exercise (as explained in Section 2 above).

3.1. Direct royalty flows - technology level

Direct royalty outflows from Germany

56. All SEP royalty payments by manufacturers headquartered in Germany to foreign SEP holders are direct royalty outflows, regardless of the country of sale. The estimation of royalty outflows from Germany follows two principal steps. In a first step, we identify German OEMs that pay SEP royalties to foreign SEP licensors. In a second step, we quantify the SEP royalties paid by German firms to foreign SEP holders (i.e. the royalty outflows from Germany).

57. **Major German OEMs that pay SEP royalties to foreign SEP holders**. German car OEMs globally sold about 11.5 million passenger cars in 2022.[30] While there are many smaller German OEMs paying SEP royalties, we are not aware of any major German OEM selling products implementing standards that would trigger SEP royalties of a similar order of magnitude. Therefore, German car OEMs likely account for the vast majority of SEP royalty payments by German OEMs to foreign SEP holders.

58. **Direct SEP royalty outflows**. In light of the above, the SEP royalties paid by German car OEMs to foreign members of the Avanci pool serves as lower bound for direct royalty outflows from Germany.[31] We found in Section 2 that all of the 17 largest individual licensors with documented licensing revenues are foreign companies and that only 1.4% of the Avanci licensing revenue would accrue to the German SEP licensors.[32] By multiplying the total Avanci royalty income (including royalties ultimately accruing to individual licensors listed in Table 1 above) from sales by German OEMs (around EUR 94 million) with the share of non-German Avanci licensors (98.6%), we estimate that direct royalty outflows from Germany amounted to EUR 93 million in 2022.

59. As mentioned in Section 2.2, other studies estimate that global SEP royalties in the mobile telecommunications industry amount to EUR 14-18 billion per year and are therefore 59% higher than our estimated EUR 11.3 billion. For the estimation of an upper bound for direct royalty outflows from Germany that reflects that we may generally underestimate total SEP royalties, we scale up the lower bound by 59% to arrive at direct royalty outflows of EUR 148 million in 2022.

Direct royalty inflows into Germany

60. As explained above, SEP royalty payments from foreign manufacturers to German SEP holders are direct royalty inflows, regardless of whether these royalties are triggered by sales inside or outside Germany.

61. In estimating a lower bound for direct royalty inflows into Germany, we first derive the total SEP royalty income of German SEP licensors that are part of our global SEP landscape and then determine the portion of those SEP royalties that are paid by non-German OEMs.[33]

62. While none of the identified individual SEP licensors with documented licensing revenues (Table 1) are German firms, we identified the above-mentioned four German SEP licensors (i.e. Deutsche Telekom, Robert Bosch, Siemens and Fraunhofer) that license their SEPs

30 Data on passenger car sales by OEM and vehicle type are obtained from Statista, Passenger Cars – Worldwide, available at https://www.statista.com/outlook/mmo/passenger-cars/worldwide. Figure aggregates sales on parent group level and incudes BMW Group, Volkswagen AG, Mercedes-Benz Group and Wiesmann.

31 Among the Avanci licensors, we identified 3 German licensors, namely Fraunhofer, Siemens and Deutsche Telekom AG. In October 2023, the Avanci 4G Vehicles pool has 57 licensors.

32 See Footnote 26 and Appendix A for further detail.

33 As explained before, our SEP landscape is not exhaustive. There are likely additional German SEP holders that are not included in our global SEP landscape. Furthermore, for several SEP holder, including the four German SEP holders, we only consider SEP royalty income through pools. Those SEP holders may also generate *additional* SEP royalty revenue through bilateral agreements outside of licensing pools. In the absence of documented licensing revenue however, we do not attempt to estimate those additional revenues.

through patent pools for which we estimated SEP royalties. As derived in Section 2.3, we estimate that German SEP holders received SEP royalties of EUR 36 million in 2022.

63. Given that only SEP royalties paid by non-German manufacturers are royalty inflows, we now turn to determining the portion of those SEP royalties that are paid by non-German manufacturers. In doing so, we distinguish between manufacturers of smartphones and non-smartphone devices. With all major smartphone OEMs being foreign companies, all SEP licensing revenues accruing from the sale of smartphones are direct royalty inflows. Similarly, non-German OEMs account for a significant portion of global non-smartphone sales. Using the share of global passenger car sales by non-German OEMs as a proxy,[34] around 82% of non-smartphone SEP licensing revenue generated by German SEP holders are paid by non-German manufacturers and constitute direct royalty inflows. Based on these assumptions, direct royalty inflows into Germany amounted to at least EUR 33 million in 2022.

64. In order to reflect that we may generally underestimate total SEP royalties, we again scale up the lower bound by 59% and arrive at an upper bound of EUR 52 million.

3.2. Indirect royalty flows - product level

Indirect royalty outflows

65. As described above, indirect royalty outflows are defined as SEP royalties paid by foreign firms that are passed on to German customers in the form of higher product prices. To estimate indirect royalty outflows from Germany, we therefore first determine the SEP royalties that foreign firms pay for the sale of licensed products to German consumers. In a second step, we then estimate the degree to which foreign OEMs pass on these royalty payments to German consumers in the form of higher prices, thereby generating indirect royalty outflows from Germany.

66. For the first step, we calculate foreign firms' SEP royalty payments for licensed products sold to German consumers by multiplying the global SEP royalties paid by foreign firms with the share of those same royalties linked to product sales in Germany.

67. As German car OEMs likely account for the vast majority of SEP royalty payments by German OEMs, the global SEP royalties paid by foreign firms corresponds to the global SEP licensing revenue after excluding the SEP royalties of EUR 94 million paid by German car OEMs in 2022. Under those assumptions, foreign firms paid EUR 11.3 billion in global SEP royalties in 2022.

68. The majority of those SEP royalties are paid for sales outside of Germany, and therefore do not constitute royalty outflows from Germany. In calculating the share of global SEP royalties linked to sales in Germany, we distinguish between smartphone and non-smartphone sales and determine the German share of global smartphone and non-smartphone sales. We assume that foreign firms' global SEP royalty payments linked to

34 Data on passenger car sales by OEM is obtained from Statista, *Passenger Cars – Worldwide*, available at https://www.statista.com/outlook/mmo/passenger-cars/worldwide.

sales in Germany are proportional to the German share of global smartphone and non-smartphone sales.[35]

69. According to research conducted by Statista, with 22 million smartphones sold in Germany in 2022 Germany accounts for merely 1.4% of the 1.5 billion smartphone sales throughout the world in 2022.[36] Similarly, the share of global non-smartphone SEP royalties associated with non-smartphone sales in Germany is assumed to correspond to Germany's share of total global consumer electronics sales (2.2%, based on 130 million units sold in Germany and 6 billion units sold globally in 2022).[37]

70. Our research therefore suggests that foreign firms paid EUR 177 million in SEP royalties for licensed products sold to German consumers (Table 3). We consider this number a conservative lower bound as our global SEP licensing landscape remains incomplete given the lack of transparency in the SEP licensing market.

Table 3: SEP royalties paid by foreign OEMs – Lower bound

	Smartphone	Other consumer electronics	Total
Global SEP royalty payments of foreign OEMs	EUR 8.9 billion	EUR 2.4 billion	EUR 11.3 billion
Share of SEP royalty payments linked to Germany	1.4%	2.2%	-
SEP royalty payments of foreign OEMs associated with German sales	EUR 126 million	EUR 51 million	EUR 177 million

Source: CRA.

71. SEP royalties paid by foreign OEMs for German sales result in indirect royalty outflows to the extent that German consumers pay a higher price because of the asked SEP royalties. In a second step, we therefore estimate the extent to which foreign OEMs incorporate SEP royalties the pricing of their products. In economic terms, the extent to which these royalties are ultimately borne by German consumers depends on the degree to which OEMs pass on royalty payments to German consumers.

72. We are not aware of any empirical evidence regarding the pass on of SEP royalties to consumers in Germany. Economic considerations provide some guidance for the rate at which OEMs likely pass on SEP royalties to consumers. In our economic reasoning, we

35 In practice, the average royalty fee per sold unit in Germany likely differs from the global average royalty fee. For simplicity, we assume that the average SEP royalty burden for a licensed product sold in Germany does not materially differ from the global average SEP royalty burden. We consider this a conservative assumption since many SEP licensors seek royalty rates for cellular SEPs based on the end device's value, and average German sales prices are likely to be higher than the global average. Therefore, the distribution of total royalties based on the share of shipments (as opposed to revenues) is likely underestimating the royalties that are generated from German sales and thus German royalty outflows.

36 See Statista, Market Insights on Smartphones, available at https://www.statista.com/outlook/cmo/consumer-electronics/telephony/smartphones/worldwide#volume (last accessed 18 June 2023).

37 See Statista, Market Insights on Consumer Electronics, available at https://www.statista.com/outlook/cmo/consumer-electronics/worldwide (last accessed 18 June 2023).

focus on smartphones and consumer electronics products, which make up for the great majority of royalty bearing sales. Basic economic theory about companies' pass-on of costs suggests that OEMs are likely to pass on SEP royalties to a significant extent. In particular, economic theory predicts that the following industry characteristics are associated with high pass-on rates:

- *First*, SEP royalties typically constitute variable costs for potential licensees such as smartphone or consumer electronics OEMs.[38]
- *Second*, SEP royalties constitute industry-wide costs as the main connectivity standards are used by virtually all manufacturers in the smartphone/consumer electronics industry who therefore are required to take out licences for the respective SEPs.[39]
- *Third*, the smartphone and consumer electronics markets are generally characterised by intense competition between OEMs which further increases the likelihood of pass-through.[40] Even in the instances where an OEM may not pass-through these costs, there exists the possibility of dampened downstream innovation and product development as a result of the manufacturer having to absorb these costs.

73. In the absence of empirical evidence for pass-on rates in Germany, and in light of the above-mentioned economic considerations, we assume – likely conservatively – that OEMs pass on only 50% of the SEP royalty payments to consumers in the form of higher prices. The expectation of a high level of pass-through is further supported by expert testimony in litigation in the smartphone sector, according to which *"each $1.00"* of a SEP licensor's *"royalty overcharge was passed through to consumers as an approximately $0.88 increase in the quality-adjusted prices of cell phones."*[41]

74. With foreign OEMs having paid EUR 177 million in SEP royalties in 2022 for licensed products sold to German consumers, and passing on 50% of those royalties to consumers, we estimate a lower bound for indirect royalty outflows of EUR 89 million.

75. The lower bound underestimates indirect royalty outflows from Germany for several reasons. Apart from the previously mentioned underestimation of global SEP royalties due

38 According to standard economic theory, a firm's variable costs (i.e. costs that vary with the firm's output) affect its pricing decisions in the short-term, not its fixed costs (e.g., Belleflamme and Peitz (2010) – Industrial Organization, Cambridge University Press). For this reason, changes in variable costs are more likely to be passed on than changes of a firm's fixed costs.

39 The degree to which a firm can pass on a cost increase also depends on whether only the firm itself or also its competitors were affected by the cost increase. Economic theory suggests that the pass-through rate is generally higher in case of an industry-wide cost increase than a firm-specific cost increase (e.g., Verboven and van Dijk (2009) – Cartel Damages Claims and the Passing-on Defense, The Journal of Industrial Economics, Vol. 57, pp. 457-491)

40 A more competitive market implies that a firm has less pricing power as customers can switch away if the firm departs from the market price. In other words, firms in more competitive markets largely act as price-takers, implying little pass-through of firm specific cost changes. In contrast, as long as the cost-increase affects a large number of firms in the market, pass-through rates typically increase with the intensity of competition.

41 See "*Order Granting Plaintiffs' Motion for Class Certification; Denying Qualcomm's Motion to Strike the Declaration of Kenneth Flamm*", *In re Qualcomm Antitrust Litig*., case 17-MD-02773-LHK, document 760, filed on 27 September 2018, at 36, discussing the economic model of plaintiffs' expert Dr. Kenneth Flamm.

to many SEP licensors not making public their licensing revenue, we underestimate the share of SEP royalty payments linked to sales in Germany for at least two reasons:

- *First*, by distributing foreign firms' global SEP royalty payments proportional to the German share of global smartphone and non-smartphone sales volumes, we implicitly assume that per-unit rates in Germany are not materially different from the average global per-unit rates. In practice, however, the per-unit SEP royalties in Germany might be higher than the global average.

  For instance, SEP royalties can increase with device prices, and the average German smartphone and consumer electronics devices are, respectively, around 38% and 57% more expensive than the average global device.[42]

  Moreover, SEP holders might charge different rates by region, and per-unit rates in an industrialised country such as Germany are likely higher than the average global per-unit rate. For instance, in Unwired Planet v. Huawei, it was found that "[t]he comparable licences show that rates are often lower in China than for the rest of the world. The relative factor varies. I find that a FRAND licence would use a factor of 50%."[43]

  For the calculation of the upper bound, we assume that SEP royalties per device in Germany are 25% higher than the average global SEP royalties from a device sale of equal value.[44]

- *Second*, by distributing foreign firms' global SEP royalty payments proportional to the German share of global smartphone and non-smartphone sales volumes, we implicitly assume that the share of licensed devices in Germany is comparable to the global average share of licensed devices. In practice, however, the share of licensed devices in Germany is likely higher than elsewhere due to more stringent patent enforcement.

  For instance, an academic study estimates a patent enforcement index and finds that Germany has a patent enforcement index of 8.3 in 2017, compared to an average enforcement index of 6.04 in the same year. That is, the German patent enforcement index exceeds the global average by 37%.[45]

  For the calculation of the upper bound, we therefore assume that the share of licensed devices in Germany is 37% higher than the global average.[46]

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42 The average smartphones price was EUR 412 in Germany compared to a global average of EUR 299 in 2022. See Statista, Smartphones - Worldwide, Germany, available at https://www.statista.com/outlook/cmo/consumer-electronics/telephony/smartphones/. The average consumer electronics device price was EUR 133 in Germany compared to a global average of EUR 85 in 2022. See Statista, Consumer Electronics – Worldwide, available at https://www.statista.com/outlook/cmo/consumer-electronics/telephony/smartphones/worldwide.

43 Unwired Planet v Huawei, [2017] EWHC 711 (Pat), para 583.

44 We do not apply a similar adjustment to the upper bound for direct royalty outflows out of Germany, as these are primarily driven by the car OEMs' fixed per-unit royalties to the Avanci pool.

45 See Papageorgiadis & Sofka (2020), "Patent enforcement across 51 countries – Patent enforcement index 1998-2017", Journal of World Business, Vol. 55, No. 4.

46 We do not apply a similar adjustment to the upper bound for direct royalty outflows out of Germany, as these are driven primarily by German car OEMs, and we have assumed that all connected cars sold by German car OEMs are licensed.

Therefore, for the estimation of the upper bound, we first scale up the SEP royalties paid by foreign firms by 59% to account for the underestimation of global SEP royalties due to many SEP licensors not making public their licensing revenue. In the upper bound, foreign firms paid roughly EUR 14.1 billion in smartphone SEP royalties and EUR 3.8 billion in non-smartphone SEP royalties. Using the aforementioned adjustments, we assume that 3.4% of the smartphone royalties and 5.8% of the non-smartphone royalties are linked to sales in Germany.[47] Under these alternative assumptions, SEP royalty payments of foreign OEMs linked to German sales amount to EUR 692 million.

Table 4: SEP royalties paid by foreign OEMs – Upper bound

	Smartphone	Other consumer electronics	Total
Global SEP royalty payments of foreign OEMs	EUR 14.1 billion	EUR 3.8 billion	EUR 17.9 billion
Share of SEP royalty payments linked to Germany	3.4%	5.8%	-
SEP royalty payments of foreign OEMs linked to German sales	**EUR** 473 **million**	**EUR** 218 **million**	**EUR** 692 **million**

Source: CRA

76. Furthermore, we assume that, for the purpose of calculating the upper bound, OEMs pass on up to 90% of their SEP royalty payments to German customers. That is, we round up the pass-through rate that was found in the above-mentioned litigation.

77. With foreign OEMs having paid EUR 692 million in SEP royalties in 2022 for licensed products sold to German consumers, and passing on 90% of those royalties to consumers, the upper bound for the indirect royalty outflows from Germany is EUR 622 million. The large difference between the lower and upper bounds reflects the material uncertainty in estimating indirect royalty outflows.

Indirect royalty inflows

78. Indirect royalty inflows refer to SEP royalties paid by German firms that are passed on to foreign consumers in the form of higher product prices. The estimation of indirect royalty inflows into Germany mirrors the estimation of indirect royalty outflows above. Starting from the SEP royalties that German firms pay for the sale of licensed products to foreign consumers, we derive indirect royalty inflows by determining the extent to which German OEMs pass on those royalty payments.

79. As explained in Section 3.1 above, German car OEMs likely account for the vast majority of SEP royalty payments by German OEMs and paid an estimated EUR 94 million in SEP royalties in 2022. A significant portion of those SEP royalties were paid on sales in Germany, and therefore are not royalty inflows to Germany.

47 The share of global SEP royalties stemming from smartphone sales in Germany is equal to $1.4\% \times (1+38\%) \times (1+25\%) \times (1+37\%) \sim 3.4\%$. The share of global SEP royalties stemming from non-smartphone sales in Germany is equal to $2.2\% \times (1+57\%) \times (1+25\%) \times (1+37\%) \sim 5.8\%$.

80. We approximate the SEP royalties that German car OEMs pay for the sale of licensed products to foreign consumers by multiplying German car OEMs' global SEP royalty payments with the export share of the German automobile industry. With around 67% of German car OEMs' cars being exported,[48] our research suggests that German car OEMs paid EUR 63 million in SEP royalties for car sales to foreign consumers.

81. Consistent with the calculation of the lower bound of indirect royalty outflows, we assume that German OEMs pass on 50% of their SEP royalties to consumers. This results in indirect royalty inflows into Germany of EUR 31 million.

82. We now turn to the estimation of the upper bound for indirect royalty inflows. In order to reflect that we may generally underestimate total SEP royalties by as much as 59%, we again scale up SEP royalty payments of German OEMs paid to foreign consumers by 59%. We find that German OEMs paid EUR 100 million in SEP royalties on cars sold to foreign consumers.

83. Assuming that German car OEMs pass on up to 90% of their SEP royalty payments to their customers, our research suggests an upper bound for indirect royalty inflows to Germany of EUR 90 million.

3.3. Total royalty flows

84. Having estimated both royalty inflows and outflows, we next turn to a comparison of royalty flows into and out of Germany.

85. As shown in Table 5 below, aggregating direct and indirect royalty flows into and out of Germany results in total royalty outflows between EUR 182 and 770 million and total royalty inflows between EUR 64 and 142 million in 2022. Comparing total royalty outflows and inflows confirms that **Germany is a net payer of SEP royalties with a material net outflow between EUR** 117 **and** 628 **million in 2022**.[49] The wide range captures the uncertainty arising from the general lack of robust data and information on SEP royalties, which makes it difficult to derive accurate estimates of the royalty in- and outflows. Despite this remaining uncertainty, it is clear that Germany is a net licensee with a significant SEP royalty outflow in 2022.

48 Export share of the automobile industry in Germany for 2021, as provided by Statistisches Bundesamt to Statista, available at https://www.statista.com/statistics/587683/export-share-car-industry-germany/.

49 In calculating the bounds of the net-flows, we aggregate the lower bounds of royalty inflows with the lower bounds of royalty outflows and proceed analogously for the upper bounds, as well as for the aggregation of direct and indirect flows. This reflects the fact that the levels of these royalty flows are correlated, because they are subject to the same uncertainty about the level of SEP royalties. For instance, the level of SEP royalties paid by German car manufacturers (i.e. direct royalty outflow) will be highly correlated with the level of SEP royalties that will be passed on to foreign car customers (indirect royalty inflows).

Table 5: Comparison of direct and indirect SEP royalty flows into and out of Germany

Type of flow	Outflows (million EUR)	Inflows (million EUR)	Net-flows (million EUR)
Direct royalty flows	-93 to -148	33 to 52	-60 to -96
Indirect royalty flows	-89 to -622	31 to 90	-57 to -532
Total royalty flows	**-**182 **to -**770	64 **to** 142	**-**117 **to -**628

Source: CRA.

4. CONCLUSION

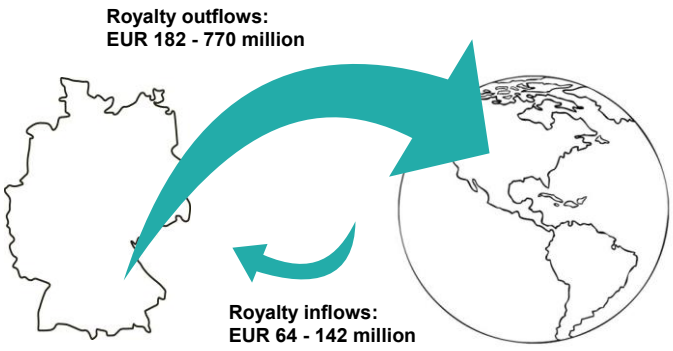
86. In summary, we estimate that the largest SEP licensors accounting for more than 99% of the estimated global SEP royalty revenues are headquartered outside of Germany. To our knowledge, no major SEP holders are headquartered in Germany. We could only identify five SEP licensors (Deutsche Telekom, Fraunhofer, Robert Bosch, Siemens, and the NPE IPCOM) with minor SEP licensing revenues that are based in Germany. On this basis, we estimate that merely about 0.3% of the global SEP royalties accrue to SEP holders headquartered in Germany.

87. SEP royalty flows take place at two different levels of the value chain: direct royalty flows at the technology level at which licensees (including component and end-device manufacturers) pay SEP royalties to SEP holders, and indirect royalty flows at the product level at which OEMs normally pass on SEP royalties at least to some extent to their customers in the form of higher prices.

88. Our research shows that Germany experiences SEP royalty outflows that exceed by far the estimated SEP royalty inflows (Figure 6 below). Net royalty outflows occur both directly and indirectly for the following reasons:

- **Direct royalty flows**. German OEMs pay materially higher SEP royalties to foreign SEP holders than foreign OEMs pay to German SEP holders. Direct royalty inflows are dwarfed by direct royalty outflows, due to the tiny SEP holdings of SEP licensors headquartered in Germany and the fact that German car manufacturers must pay SEP royalties for their global connected car sales. Our research quantifies the direct royalty net outflow to be between EUR 60 and 96 million.
- **Indirect royalty flows**. Both German and foreign OEMs are likely to incorporate SEP royalty fees into their pricing, resulting in higher prices for consumers and additional royalty flows. Our research suggests that there are sizeable indirect royalty outflows from Germany. While there are also indirect royalty inflows from German manufacturers that pass on a portion of their SEP royalties to foreign customers, these are dwarfed by indirect royalty outflows. This is because the imported volume of products that implement royalty-bearing standards (e.g. smartphones and other licensed consumer electronics products) by far exceeds the volume of such products sold by German manufacturers to foreign customers. On aggregate, we estimate the indirect royalty net outflow to be between EUR 57 and 532 million.

Figure 6: SEP royalty flows into and out of Germany



Source: CRA.

APPENDIX A: ESTIMATING GLOBAL SEP LICENSING REVENUES IN 2022

89. This appendix provides further details on the estimation of global SEP licensing revenues for the 17 individual SEP licensors (Section A.1 below) and 7 patent pools (Section A.2 below).

90. As discussed in the main text above, we focus on the largest individual SEP holders with documented licensing revenues and the patent pools with significant licensing revenue. We are therefore likely to materially underestimate the total global SEP royalties and our research should be understood as a lower bound.

A.1 Individual licensors with documented licensing revenues

91. As shown in the main text, more than 90% of our estimated global SEP licensing revenue estimated in 2022 comes from individual SEP licensors with documented licensing revenue (e.g. from annual reports).[50,51]

92. We estimate SEP royalties for these firms by reviewing their annual reports and extracting the relevant figures – usually this is categorized as licensing revenue or similar. From these figures, we make an assumption regarding what percentage of licensing revenue refers specifically to SEP licensing. We are guided by information provided within the annual reports, which often provide a short note on the components that make up licensing revenue, or by additional desk research. For instance, in instances where it is likely that licensing revenue is made up from more than just SEP licensing, but further desk research suggests that a vast majority comes from SEP licensing, we attribute 95% of licensing revenue to SEPs. The relatively high share captures that typically the SEP holder's main leverage comes from SEPs and that typically SEPs are asserted in litigation (see further company-specific details below). Having estimated total SEP licensing revenue, we then split SEP revenues between smartphones and all other products. In doing so, we are also guided either by information provided within the annual reports or by additional desk research.

93. There are two SEP licensors without documented licensing revenues in 2022 but with documented smartphone licensing revenue in 2016, as provided in Galetovic et al. (2018). These SEP licensors are Tivo and Conversant IP. To impute the 2022 SEP licensing revenues, we extrapolate from the 2016 smartphone licensing revenues estimated by Galetovic et al. More precisely, we assume that their relative share of the estimated global licensing SEP revenues remained constant over time.

50 All revenues reported in local currency (e.g. USD, SEK) were converted to EUR using the ECB's average reference exchange rate in 2022, available at https://www.ecb.europa.eu/stats/policy_and_exchange_rates/euro_reference_exchange_rates.

51 As a starting point for identifying SEP licensors, we consider all smartphone licensors identified in Galetovic, Alexander, Stephen Haber, and Lew Zaretzki (2018), An estimate of the average cumulative royalty yield in the world mobile phone industry: Theory, measurement and results, *Telecommunications Policy* 42, no. 3 (2018), pp. 263-276.

Qualcomm

- Qualcomm discloses its licensing revenue in its Form 10K.[52] In its Form 10K, Qualcomm reports revenues of USD 6.4 billion (corresponding to EUR 6 billion) for the Qualcomm Technology Licensing ("**QTL**") segment, which includes licensing revenue.
- Qualcomm states that the vast majority of its QTL revenues are generated from licensees' sales of CDMA-based (including, but not limited to, WCDMA-based) and OFDMA-based products (including 3G, 3G/4G and 3G/4G/5G multi-mode devices), such as smartphones and other devices. We therefore treat 95% of the QTL revenue as SEP licensing revenue.
- In 2022, Qualcomm also licensed its SEPs through patent pools (e.g. Avanci 4G Vehicle).
- Qualcomm does not report the share of SEP revenue that is from smartphone licensing. As the majority of Qualcomm's SEP licensing revenue is from cellular standards, we assume that smartphone sales account for 89% of Qualcomm's SEP licensing revenue. The latter share is derived as follows. Given Qualcomm's strong cellular SEP portfolio, we assume that 10% of Qualcomm's SEP licensing revenue comes from the sale of non-smartphone devices. To further reflect the recent successful licensing of car OEMs (through the Avanci pool), we further add Qualcomm's revenue from the Avanci pool to the 10% non-smartphone share. Qualcomm's revenue from the Avanci pool is derived further below.

Nokia

- Nokia reports licensing revenue of EUR 1.6 billion in its Form 20F.[53] We refer to revenue from Nokia Technologies, which is focused on patent and technology licensing. Nokia states that patent licensing and monetization drive the majority of Nokia Technologies' sales.
- In 2022, Nokia also licenses its SEPs through patent pools (e.g. Avanci 4G Vehicle and Avanci 5G Vehicle).
- Nokia refers to its "*successful mobile devices licensing program, where we currently have licensing agreements with most of the major smartphone vendors.*" Based on the above information, we assume that 95% of Nokia Technologies' licensing revenue is SEP-related. We further assume that smartphones account for 86% of Nokia's SEP licensing revenue (as for Qualcomm, the smartphone share is approximated by assuming that the non-smartphone share is 10% plus Nokia's Avanci share of SEP licensing revenue).

52 Qualcomm, Form-10K, FY2022, p. 43, available at https://investor.qualcomm.com/financial-information/sec-filings/content/0000804328-22-000021/0000804328-22-000021.pdf.

53 Nokia, Form-20F, 2022, p. 85, available at https://www.nokia.com/system/files/2023-03/nokia-form-20-f-2022.pdf.

Ericsson

- Ericsson's licensing revenue is taken from its annual report for 2022 and amounts to SEK 10.4 billion (slightly less than EUR 1 billion).[54] We refer to Ericsson's IPR revenues which relate to its patent and licensing business.
- In 2022, Ericsson also licensed its SEPs through patent pools (e.g. Avanci 4G Vehicle and MPEG LA AVC).
- There is evidence that Ericsson is significantly involved in smartphone licensing based on several litigation cases where Ericsson has been on the opposing side of major smartphone OEMs.[55] Based on these high-profile cases, we assume that 95% of Ericsson's IPR revenue come from SEP licensing.
- As for Qualcomm, the smartphone share is approximated assuming that the non-smartphone share is 10% plus Ericsson's Avanci share of SEP licensing revenue, resulting in a smartphone share of 86%.

Huawei

- Huawei's smartphone SEP licensing is based on a statement from its head of IP, Alan Fan, who said that Huawei received USD 560 million (corresponding to EUR 532 million) in royalty revenues in 2022.[56]
- In 2022, Huawei also licensed its SEPs through patent pools (e.g. Access Advance HEVC). Huawei's participation in the Avanci 4G pool was announced in 2023.
- By some accounts, Huawei is the world's largest 5G patent owner with 20% of global 5G patents.[57] Considering this presence in the licensing of SEPs for cellular standards, we assume that 95% of Huawei's licensing revenue comes from SEP licensing, and that 90% of this comes from smartphone licensing.

Philips

- Philips' licensing revenue is reported in its annual report (EUR 419 million).[58] We refer to the reported "Royalties" figures attributed to each year in the annual report.
- In 2022, Philips also licensed its SEPs through various patent pools (e.g. Access Advance HEVC, Avanci 4G Vehicles, MPEG LA AVC, Via Licensing AAC and MPEG LA MPEG-4).

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54 Ericsson, Annual Report, 2022, p. 15, available at, https://www.ericsson.com/493d1d/assets/local/investors/documents/2022/annual-report-2022-en.pdf.

55 For a summary see tables 1,2, and 4 in Love and Helmers (2022).

56 Reuters, 2023, China's Huawei says it earned patent revenues of $560 million last year, available at https://www.reuters.com/technology/chinas-huawei-says-it-earned-patent-revenues-560-mln-last-year-2023-07-13/ (last accessed 15 July).

57 See Total Telecom, 2023, *Huawei and Ericsson sign global patent licensing deal*, available at https://totaltele.com/huawei-and-ericsson-sign-global-patent-licensing-deal/ (last accessed 3 October 2023)

58 Philips, Annual Report, 2022, p. 12, available at https://www.results.philips.com/publications/ar22/downloads/pdf/en/PhilipsFullAnnualReport2022-English.pdf?v=20230426085127.)

- According to industry experts approximately 95% of Philips' royalty revenue is related to SEP licensing. We further assume that smartphones account for 29% of Philips' SEP licensing revenue (similar to Qualcomm, the smartphone share is approximated assuming that the non-smartphone share is 70%[59] plus Philips' Avanci share of SEP licensing revenue).

InterDigital

- InterDigital's licensing revenue is derived from its financial results.[60] We refer to InterDigital's recurring licensing revenues for the smartphone, CE, IoT and auto licensing programs (USD 458 million, corresponding to EUR 435 million), assuming that these relate directly to SEP licensing.
- As 87% of InterDigital's recurring licensing revenue is derived from its smartphone licensing program, we assume that 87% of InterDigital's SEP licensing revenue is derived from smartphone sales.[61]
- In 2022, InterDigital also licensed its SEPs through the Avanci 4G Vehicles pool.

IBM

- IBM's licensing revenue is taken from its annual report.[62] We refer to IBM's intellectual property and custom development income. From this division we treat revenue from "licensing of intellectual property including royalty-based fees" and "sales/other transfers of intellectual property" as licensing revenue (around EUR 397 million).
- However, only a part of IBM's IP licensing revenue comes from SEP licensing. In order to avoid overstating or understating IBM's SEP licensing revenue, and following the assumption in Galetovic et al. (2018), we assume that 50% of IBM's IP licensing comes from the licensing of SEPs. We further assume that half of the SEP licensing revenue is related to smartphones. This is because IBM is not known to license SEPs for cellular standards (e.g. IBM is not a member of the Avanci 4G or 5G Vehicles pools), and also in line with the assumption in Galetovic et al. (2018).

59 Galetovic et al (2018).

60 InterDigital, InterDigital Reports Fourth Quarter And Full Year 2022 Financial Results, available at https://ir.interdigital.com/news-events/press-releases/news-details/2023/InterDigital-Reports-Fourth-Quarter-And-Full-Year-2022-Financial-Results/default.aspx.

61 IAM Media, February 2023, *InterDigital celebrates record licensing revenues in 2022*, available at https://www.iam-media.com/article/interdigital-celebrates-record-licensing-revenues-in-2022 (last accessed 3 October 2023).

62 IBM, Annual Report 2020, p. 23, available at https://www.ibm.com/annualreport/assets/downloads/IBM_Annual_Report_2022.pdf.

Broadcom

- While Broadcom reported IP licensing revenues separately in its 2019 annual report, IP licensing revenue is not reported in the 2022 Form 10K. To approximate Broadcom's IP licensing revenue in 2022, we take the total net revenue[63] and assume that its IP licensing share remained constant since 2019 (i.e. around 0.32% of Broadcom's total net revenue.[64]
- With Broadcom being among the world's leading communications semiconductor companies and providing a wide array of wireless infrastructure and device components, we assume that 50% of Broadcom's licensing revenue is associated with SEPs, of which 50% is from smartphone licensing.

ZTE

- ZTE expects to generate licensing revenue between USD 700 million and USD 930 million between 2021 and 2025, which corresponds to around licensing revenues of roughly USD 180 million per year (EUR 162 million).[65]
- As ZTE has a large portfolio with 4G and 5G SEPs, we assume that 95% of ZTE's licensing revenue comes from the licensing of SEPs.
- In 2022, ZTE also licensed its SEPs through patent pools (e.g. Avanci 4G Vehicle, Access Advance HEVC, MPEG LA MPEG4 and MPEG LA AVC).
- As for Qualcomm, the smartphone share is approximated assuming that the non-smartphone share is 10% plus ZTE's Avanci share of SEP licensing revenue, resulting in a smartphone share of 50%.

Rambus

- Rambus's licensing revenue is taken from its 2022 Form 10K.[66] We refer to the royalty revenue directly reported in the Form 10K (USD 159 million, corresponding to EUR 151 million).
- Rambus has a broad worldwide portfolio of patents covering memory architecture, high-speed serial links and security; and Rambus states that its patented inventions are foundational to the semiconductor industry.[67] We therefore attribute 95% of this royalty revenue to SEP licensing revenue.

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63 Broadcom, Form-10K 2022, p. 42, available a https://investors.broadcom.com/static-files/d2030782-0993-4f3a-89e8-0a6efd58c552.

64 Broadcom, Form-10K 2019, p. 46, available at https://investors.broadcom.com/static-files/f81d3fbb-755c-44a7-ab4d-8b5fe16633fb.

65 Bing Zhao (IAM Media), July 2021, *ZTE targets up to $930 million in patent revenue over the next five years*, available at https://www.iam-media.com/article/zte-targets-930-million-patent-licensing-revenue-over-next-five-years (last accessed 21 October 2023).

66 Rambus, Form-10K 2022, p. 36, available at https://d18rn0p25nwr6d.cloudfront.net/CIK-0000917273/4db100bd-03ff-42b9-8b49-c69edb964e18.pdf.

67 Rambus, Form-10K 2022, p. 4, available at https://d18rn0p25nwr6d.cloudfront.net/CIK-0000917273/4db100bd-03ff-42b9-8b49-c69edb964e18.pdf.

- Rambus primarily manufactures DRAM, which is used in a wide variety of applications. To determine the share of Rambus's licensing revenue attributable to smartphones, we multiply SEP licensing revenue by the percentage of DRAM revenue derived from mobiles. This share was estimated by Seeking Alpha (as cited by Statista) to be 41% in 2019,[68] and we assume the share remains unchanged in 2022.

Acacia Technologies

- Acacia Technologies licensing revenue is derived from its 2022 Form 10K.[69] Within the Form 10K Acacia states that the revenue is derived from various licensing and enforcement programs for a number of different technologies. For deriving licensing revenues, we refer to "paid-up licensing revenue agreements" and "recurring licence revenue agreements" which together amount to around USD 19 million (corresponding to EUR 19 million).
- Acacia Research frequently engages in litigation over SEPs.[70] We therefore assume that 95% of Acacia's licensing revenue is SEP licensing. We further assume that 90% of Acacia's SEP revenue is driven by smartphone licensing.

ParkerVision

- ParkerVision reported licensing revenue in its 2022 Form-10K.[71] We assume that 95% of the reported licensing revenue is from SEPs and that a further 80% of SEP royalties are from the sale of licensed smartphones.
- According to the founder, "*ParkerVision has invested hundreds of millions of dollars in R&D and marketing in its patented RF receiver and transmitter technologies to enable ultra-small semiconductor chips that deliver high-performance RF wireless communications for mobile telephone standards such as 3G, 4G, and 5G, WiFi® communications.*"[72] We therefore assume that 95% of the reported licensing revenue is from SEPs, of which a further 90% is from the sale of licensed smartphones.

68 We estimate mobile's share of the DRAM market based on data from Statista, see https://www.statista.com/statistics/1055249/global-dram-shipment-share-by-segment/

69 Acacia Technologies, Form-10K 2022, p. 31, available at https://www.annualreports.com/HostedData/AnnualReports/PDF/NASDAQ_ACTG_2022.pdf.

70 See, for instance, RPX Insight, May 2023, *In Wi-Fi 6 Litigation, Acacia Sues a Duo of Domestic Defendants*, available at https://insight.rpxcorp.com/news/75119-in-wi-fi-6-litigation-acacia-sues-a-duo-of-domestic-defendants (last accessed 3 October 2023).

71 ParkerVision, Form-10K 2022, p. 26, available at https://www.sec.gov/Archives/edgar/data/914139/000143774923008226/prkr20221231_10k.htm.

72 Yahoo! Finance, August 2023, *ParkerVision Reports Profitable First Half of 2023*, available at https://finance.yahoo.com/news/parkervision-reports-profitable-first-half-200100194.html (last accessed 3 October 2023)

VirnetX

- VirnetX reports its licensing revenues in its 2022 Form-10K (USD 48 thousand, corresponding to EUR 46 thousand).[73] In deriving its 2022 revenues, we further spread VirnetX's 2020 lump sum payment from Apple (around EUR 290 million) over 8 years, resulting in total SEP licensing revenues of around EUR 34 million in 2022.[74]
- As the majority of VirnetX's licensing revenues if coming from the Apple lump-sum payment,[75] we conservatively assume that 95% of VirnetX licensing revenue is attributable to SEP licensing, and that 90% of that licensing revenue is coming from smartphones.

Blackberry

- Blackberry reports its licensing revenues in its 2022 Form-10K (USD 32 million, corresponding to EUR 30 million).[76] We assume that 95% of the reported licensing revenue is from SEPs and that smartphones account for 79% of BlackBerry's SEP licensing revenue (as for Qualcomm, the smartphone share is approximated assuming that the non-smartphone share is 90% plus BlackBerry's Avanci share of SEP licensing revenue).

PanOptis

- PanOptis licensing revenue is the sum of the revenue from the PanOptis vs. Apple jury verdict of 2021 and the licensing revenue derived from the Avanci 4G Vehicles program.
- More specifically, the jury awarded PanOptis a lump sum of USD 300 million (around EUR 285 million) in PanOptis vs. Apple.[77] We spread the lump-sum from the jury verdict across 8 years (which reflects a standard generation lifetime).
- In 2022, PanOptis licensed its SEPs through the Avanci 4G Vehicles pool. We estimate that PanOptis received around EUR 2.5 million from the Avanci 4G Vehicles program (see details on the Avanci pool further below).

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73 VirnetX, Form-10K 2022, p.29, available at https://ir.virnetx.com/static-files/654942a0-11df-4063-ae3f-779158f069ec.

74 VirnetX, Form-10K 2022, p.29, available at https://ir.virnetx.com/static-files/654942a0-11df-4063-ae3f-779158f069ec.

75 VirnetX, Form 10-K, FY 2020, p. 27, available at https://www.sec.gov/Archives/edgar/data/1082324/000114036121008678/brhc10021150_10k.htm (last accessed on 21 October 2023). In case 6:10-CV-00417-LED, VirnetX was awarded $368,000 for Apple's infringement of four US patents, all of which were declared essential to various 3GPP technical specifications in relation to the LTE standard. See Bekkers, R., Catalini, C., Martinelli, A., & Simcoe, T. (2012), Intellectual Property Disclosure in Standards Development, Proceedings from NBER conference on Standards, Patents & Innovation, Tucson (AZ), January 20 and 21, 2012.

76 Blackberry, Form-10K 2022, p.49, available at https://www.blackberry.com/us/en/pdfviewer?file=/content/dam/bbcomv4/blackberry-com/en/company/investors/financial-reports/2023/q4y2023/BlackBerry-Fiscal-2023-10-K.pdf.

77 PanOptis, PanOptis vs. Apple jury verdict 2021, p.4, available at https://fingfx.thomsonreuters.com/gfx/legaldocs/zjvqkkqolvx/IP%20APPLE%20OPTIS%20verdict.pdf.

- We assume that 100% of the reported licensing revenue is from SEPs. As for Qualcomm, the smartphone share is approximated assuming that the non-smartphone share is 10% plus PanOptis' Avanci share of SEP licensing revenue, resulting in a smartphone share of 84%.

SEP licensors with documented licensing revenue in 2016

- There are two SEP licensors without documented licensing revenues in 2022, but with documented smartphone licensing revenue in 2016, as documented in Galetovic et al. (2018). Those SEP licensors are Tivo and Conversant IP.
- The royalties of these licensors for 2022 are estimated by extrapolating the 2016 estimates by Galetovic et al. More precisely, this extrapolation involves working out the share of 2016 smartphone royalties attributable to each of those licensors with no new information, and then maintaining this share as a proportion of 2022 total smartphone licensing revenues. Each of these extrapolated licensor's 2022 licensing revenue figures is multiplied by 90%, to account for the fact that the firms' smartphone licensing revenue is unlikely to stem entirely from SEP royalties.

A.2 Patent pools

94. As mentioned in the main text, we only estimate SEP licensing revenues for SEP licensors with documented licensing revenue, which understates global SEP licensing revenue. By estimating the SEP licensing revenues of patent pools, we can at least partially account for the SEP licensing revenues of licensors that do not disclose their licensing revenue.

95. There exist a multitude of patent pools offering licence programs for many different standards. However, pools greatly vary in their licensed volumes. We identified 7 licensing programs of patent pools for which we estimate SEP licensing revenues, namely Avanci (4G Vehicles), Access Advance (HEVC), MPEG LA (AVC, HEVC and MPEG-4) and Via Licensing (AAC, WCDMA).

96. For the purposes of this study, we estimated the licensing revenues of the Avanci 4G Vehicles, Via Licensing AAC and MPEG LA MPEG-4 pools bottom-up, that is, we first derive the licensed volumes and then multiply with per unit royalty rates. A bottom-up estimation is possible because in contrast to individual SEP holders, patent pools typically disclose both licensees and headline royalty rates. Combining this with the licensees' estimated sales volumes allows us to approximate the pools' total licensing revenues.[78] For the Access Advance HEVC, MPEG LA HEVC and MPEG LA AVC, drawing on third-party estimates, we estimate the total SEP licensing revenue top-down. That is, we first estimate the total licensing revenue for the standard and then distribute that licensing revenue among the various patent pools.[79]

97. As explained in the main text, some of the individual licensors with documented licensing revenue also license their SEPs via patent pools. For those SEP licensors, any SEP revenues received through patent pools is already included in their documented licensing revenue. In the estimation of global SEP licensing revenue, we account for the double

78 This approach implies that we estimate a patent pools' annual running royalty income and disregard any royalty payments for past years' sales.

79 Due to the lack of sufficient information, neither a bottom-up nor top-down approach could be applied for the Via Licensing WCDMA pool for which the estimate is based on an extrapolation of Galetovic et. al.'s estimate for 2016.

counting of revenues by removing the duplicative revenues from the patent pools' revenues. In the below, we describe for each patent pool the methodology to do so.

Avanci Vehicle 4G

- The Avanci Vehicle 4G pool offers a licence for connected vehicles (2G, 3G and 4G). Until 31 August 2022, the Avanci 4G pool charged USD 15 per vehicle for a 4G licence (including 2G, 3G and eCall). Since September 2022, a 4G licence costs USD 20 per vehicle. The royalty fees for 3G (including 2G and eCall) and eCall are USD 3 and USD 9 per vehicle, respectively. We conservatively assume that Avanci offered all OEMs that took a licence in 2022 a 4G royalty rate of USD 15 per vehicle.
- For each licensee of the Avanci Vehicle 4G pool, we estimate the SEP royalties based on the pool's fee structure and the licensees' car sales in 2022.[80] Not all cars sold in 2022 are connected vehicles. We estimate the share of 4G-connected cars assuming that 90% of luxury cars, 50% of regular cars, and 10% of cheap cars sold in 2022 were connected vehicles.[81] Following this approach, we estimate that the Avanci Vehicle 4G pool generated around EUR 488 million in annual SEP licensing revenue in 2022 (Table 6 below).

Table 6: Annual licensed vehicles with built-in 4G connectivity in 2022

Vehicle Type	Number of licensed 4G vehicles (million)	Licensing Revenue (million EUR)
Luxury Cars	25.6	365.1
Regular Cars	7.5	106.6
Small Cars	1.1	16.4
Total	**34.3**	**488.1**

Source: CRA.

- Next, we identify the annual SEP licensing revenue of the Avanci 4G Vehicles pool that accrues to individual SEP licensors with documented licensing revenue.[82] To do so, we assume that Avanci distributes the total SEP licensing revenue proportionally to the family share each licensor contributes to the pool. We identified the following SEP licensors that were members of the Avanci 4G Vehicles pool in 2022, own 4G SEPs, and whose SEP licensing revenue we already estimated: Qualcomm, ZTE, Nokia, Ericsson, InterDigital, BlackBerry, PanOptis, Conversant and Philips. Following this approach, we estimate that EUR 258 million of Avanci's total licensing revenue is due to those licensors (Table 7 below). In other words, the Avanci 4G Vehicles pool earned annual SEP licensing revenues of around EUR 230 million after adjusting for the double-counting.

80 Data on passenger car sales by OEM and vehicle type are obtained from Statista, *Passenger Cars – Worldwide*, available at https://www.statista.com/outlook/mmo/passenger-cars/worldwide.

81 The luxury category includes executive cars, full-size vans, large cars, luxury cars and SUVs. The regular segment includes medium cars and pickup trucks. The cheap segment includes mini cars, minivans and small cars.

82 We only consider licensors that were part of the Avanci 4G Vehicles pool in 2022.

Table 7: Total SEP licensing revenue generated by the Avanci 4G Vehicles pool that accrues to individual SEP licensors with documented licensing revenue

SEP Licensor	Share of 4G families within the Avanci pool	Total SEP licensing revenue (million EUR)
Qualcomm	13.6%	66.4
ZTE	13.3%	64.8
Nokia	12.4%	60.8
Ericsson	6.9%	33.8
InterDigital	4.4%	21.5
Philips	0.8%	3.9
BlackBerry	0.7%	3.5
PanOptis	0.5%	2.5
Conversant	0.2%	1.1
Total	52.9%	258.1

Source: CRA based on IPlytics data on 4G SEPs.

MPEG LA HEVC

- The MPEG LA HEVC pool royalty rates are structured as follows:

Table 8: MPEG LA HEVC royalty structure

Units (Millions)		Royalty Rate per Unit ($)
From unit number	To unit number	
0	0.1	0
0.1	125.1	0.2
125.1	>125.1	0

Source: https://www.mpegla.com/wp-content/uploads/HEVCweb.pdf

- Annual royalties per licensee are capped at USD 25 million (EUR 23.7 million). To hit this enterprise cap, a smartphone OEM would have to sell 125.1[83] million units in 2022. Both Apple and Xiaomi exceeded this figure in 2022 and therefore would pay USD 25 million (EUR 23.7 million) each. This totals to USD 50 million (EUR 47.5 million) in smartphone licensing revenue being generated by the MPEG LA HEVC pool in 2022. No other major smartphone OEM is identified within the licensee list. Royalties paid by smaller smartphone OEMs are not included in patent pool calculations. This

83 This can be calculated as $100{,}000\ units \times \$0 + 125{,}000{,}000\ units \times \$0.2 = \$25{,}000{,}000$

acts to conservatively restrict total royalties that come from patent pools. Table 9 outlines the MPEG LA HEVC pool total royalties generated from smartphone sales.

- Based on the royalty structure, and the list of licensees within the MPEG LA HEVC pool, we estimate total smartphone royalties as shown below:

Table 9: MPEG LA HEVC calculated smartphone royalties (2022)

Smartphone Producer	Sales (million units)	Licensee of Pool	Royalties Paid (million EUR)
Apple	226	Yes	23.7
Xiaomi	153	Yes	23.7
Total	**-**	**-**	**47.5**

Source: CRA calculations based on pool royalty rates and sales of major smartphone licensees within the pool. Licensee list available at https://www.mpegla.com/programs/hevc/licensees/. Conversion of royalties in USD to EUR with ECB's annual average exchange rate in 2022.

Notes: We do not identify any other significant smartphone OEM within the licensee list. Samsung ceased being a licensor from the MPEGLA HEVC pool in March 2020. Samsung was also a licensor of the pool before March 2020, so we assume net royalty revenues and payments were likely netted out. "Others" include ZTE, Realme, Lenovo, LG, Tecno, Nokia, Google, Sony, and HTC, who are not featured on the pool's licensee list.

- We estimate the total pool licensing revenue (including licensed non-smartphone devices) by multiplying the total addressable market[84] with the share of licensed devices – the latter is assumed to be 20% in the case of HEVC. The total global licensing revenue for all HEVC licensors is therefore estimated to be USD 430 million in 2022 (EUR 408 million). We then distribute this revenue among the pools and other licensors using patents shares. With MPEG LA's HEVC pool accounting for roughly 20% of the HEVC landscape,[85] we estimate that the MPEG LA HEVC pool generated SEP royalties of USD 91 million (EUR 86 million) in 2022. This implies that 55% of the licensing revenue of the MPEG LA HEVC pool comes from smartphones.

MPEG LA MPEG4

- The MPEG LA MPEG4 pool royalty rate structure is shown in Table 10. In order to hit the USD 3.75 million (EUR 3.56 million) pool royalty cap, a smartphone OEM would have to sell 37.55 million units per year.[86]

Table 10: MPEG LA MPEG4 royalty structure

Units (Millions)		Royalty Rate per Unit (USD)
From unit number	To unit number	

84 Rethink Technology Research Services: Media & Entertainment Transcoding Workload and Device Royalty Forecast 2020-2030.

85 Access Advance, HEVC Worldwide Essential Patents Landscape, July 2022 Status of HEVC licensing – Patent Owners/Patent Count.

86 $50{,}000\ units \times \$0 + 37{,}500{,}000\ units \times \$0.1 = \$3{,}750{,}000$

0	0.05	0
0.05	37.55	0.1
37.55	> 37.55	0

Source: https://www.mpegla.com/wp-content/uploads/m4vweb.pdf

- Based on the royalty structure, and list of licensees within the MPEG LA MPEG4 pool, we estimate total smartphone royalties as shown below:

Table 11: MPEG LA MPEG-4 calculated smartphone royalties (2022)

Smartphone Producer	Sales (million units)	Licensee of Pool	Royalties Paid (million EUR)
Apple	225	Yes	3.56
Nokia	7	Yes	0.69
HTC	2	Yes	0.14
Total	**-**	**-**	**4.4**
Total (minus licensors already documented)	**-**	**-**	**4.1**

Source: CRA calculations based on pool royalty rates and sales of major smartphone licensees within the pool. Licensee list available at https://www.mpegla.com/programs/mpeg-4-visual/licensees/. Conversion of royalties in USD to EUR with ECB's annual average exchange rate in 2022.

- To remove instances of double counting, we remove royalties attributable to licensors already separately identified in our analysis. Philips and ZTE are listed as licensor to the MPEG LA MPEG-4 pool. We remove its royalties from the pool by assuming Philips and ZTE earn royalty revenues in proportion to their share of all patents in the pool. Philips and ZTE together own 85 patents. The pool counts 1,480 patents in total.[87]

MPEG LA AVC H.264

- Table 12 shows the royalty structure of the MPEG LA AVC H.264 pool. In order to hit the USD 9.75 million pool royalty cap (EUR 9.26 million), a smartphone OEM would have to sell 92.7 million units per year.[88]

Table 12: MPEG LA AVC H.264 royalty structure

Units (Millions)		Royalty Rate per Unit (USD)
From unit number	To unit number	
0	0.1	0
0.1	5	0.2

87 https://www.mpegla.com/wp-content/uploads/m4v-att1.pdf

88 $100{,}000\ units \times \$0 + 4{,}900{,}000 \times \$0.2 + 87{,}700{,}000 \times \$0.1 = \$9{,}750{,}000$

5	92.7	0.1
92.7	>92.7	0

Source: https://www.mpegla.com/wp-content/uploads/avcweb.pdf

- Based on the royalty structure, and list of licensees within the MPEG LA AVC H.264 pool, we estimate total smartphone royalties as shown below:

Table 13: MPEG LA AVC H.264 calculated smartphone royalties (2022)

Smartphone Producer	Sales (million units)	Licensee of Pool	Royalties Paid (€ million)
Samsung	260	Yes	9.26
Apple	225	Yes	9.26
Huawei	28	Yes	3.11
Xiaomi	152	Yes	9.26
OPPO	118	Yes	9.26
Vivo	100	Yes	9.26
Others*	101	Yes	11.86
Total	**-**	**-**	**61.3**
Total (Minus licensors already documented)	**-**	**-**	**60.6**

Source: CRA calculations based on pool royalty rates and sales of major smartphone licensees within the pool. Licensee list available at https://www.mpegla.com/programs/avc-h-264/licensees/.

Notes: * "Others" include licensees Sony, Google, Lenovo and ZTE.

- To account for instances of double counting, we again remove royalties attributable to licensors already separately identified in our analysis, namely Philips, Ericsson and ZTE. We remove their royalties from the pool by assuming each licensor earns royalty revenue from the pool in proportion to their share of all patents in the pool. ZTE has 2 patents, whilst Philips has 47 patents and Ericsson has 35 patents. Total patents in the pool were 7,705.[89]

89 https://www.mpegla.com/wp-content/uploads/avc-att1.pdf

- Total pool licensing revenue (including licensed non-smartphone devices) is calculated assuming that 60% of the total addressable market is licensed.[90] The total global licensing revenue for all AVC licensors is therefore estimated to be USD 316 million (EUR 300 million) in 2022. With MPEG LA accounting for roughly three-quarter of the AVC landscape,[91] we estimate that the MPEG LA AVC pool generated SEP royalties of USD 240 million (EUR 228 million) in 2022. This implies that 60% of the licensing revenue of the MPEG LA AVC pool comes from smartphones.

Access Advance HEVC

- The Access Advance pool smartphone royalty rates are structured as follows:
    i. For region 1 sales, royalties are a flat rate of USD 0.4/unit.[92]
    ii. For region 2 sales, royalties are a flat rate of USD 0.2/unit.
    iii. Royalties are capped at USD 30 million (EUR 28.5 million).
- Region 1 includes all sales of smartphones made in the following countries:

Figure 7: Access Advance region 1 country list

Member States of the EU All current and future members. List effective as of 2/2015.		Other European/Atlantic	North America	Middle East	Asia Pacific
Austria	Italy	Andorra	Canada	Bahrain	American Samoa
Belgium	Latvia	Bermuda	United States	Israel	Australia
Bulgaria	Lithuania	Iceland		Kuwait	Guam
Croatia	Luxembourg	Liechtenstein		Qatar	Hong Kong
Cyprus	Malta	Monaco		Saudi Arabia	Japan
Czech Republic	Netherlands	Norway		United Arab Emirates	Malaysia
Denmark	Poland	Puerto Rico			New Zealand
Estonia	Portugal	San Marino			Northern Mariana
Finland	Romania	Switzerland			Islands
France	Slovakia	Turkey			Singapore
Germany	Slovenia	UK			South Korea
Greece	Spain	U.S. Virgin Islands			Taiwan
Hungary	Sweden	Vatican City			
Ireland					

Source: https://accessadvance.com/hevc-advance-patent-pool-detailed-royalty-rates/

90 Rethink Technology Research Services: Media & Entertainment Transcoding Workload and Device Royalty Forecast 2020-2030.

91 Armstrong, Mueller, Syrett, 2014, *The Smartphone Royalty Stack: Surveying Royalty Demands for the Components within Modern Smartphones*, available at https://www.wilmerhale.com/insights/publications/the-smartphone-royalty-stack.

92 See https://accessadvance.com/wp-content/uploads/2021/06/HEVC-Advance-Program-Overview-Platform-Dec-2021.pdf slide 31. We assume all licensees are in-compliance with a trademark discount.

- Region 2 sales are those made in all countries not listed above. Based on the above royalty structure, a smartphone OEM would have to sell 75 million units in region 1 or 150 million units in region 2 to hit the royalty cap of USD 30 million (EUR 28.5 million).[93] Smartphone sales in region 1 amounted to 28% of total global smartphone sales in 2020, while the remaining 72% were accordingly sold in region 2.[94] We assume that the average shares of region 1 and 2 sales also hold for the sales of all individual licensees that do not sell more than 150 million units. For those licensees selling above this total, the enterprise cap holds regardless of the shares of sales in region 1 and 2. Based on the royalty structure, and list of licensees within the Access Advance pool, we estimate total smartphone royalties as shown below:

Table 14: Access Advance calculated smartphone royalties (2022)

Smartphone Producer	Sales (million units)	Licensee of Pool	Royalties Paid (million EUR)
Samsung	260	Yes	28.5
Huawei	28	Yes	28.1
OPPO	118	Yes	6.6
Vivo	100	Yes	23.7
Google	3	Yes	0.8
LG	23	Yes	5.4
ZTE	41	Yes	9.8
Total	**-**	**-**	**102.9**
Total (minus licensors already documented)	**-**	**-**	**98.9**

Source: CRA calculations based on pool royalty rates and sales of major smartphone licensees within the pool. Licensee list available at https://accessadvance.com/hevc-advance-patent-pool-licensees/. Conversion of royalties in USD to EUR with ECB's annual average exchange rate in 2022.

- To account for instances of double counting, we remove royalties attributable to licensors already separately identified in our analysis, namely Huawei, Philips and ZTE. We remove their royalties from the pool by assuming each licensor earns royalty revenue in proportion to their share of all patents in the pool.

93 For region 1: $75{,}000{,}000\ units \times \$0.4 = \$30{,}000{,}000$, for region 2: $150{,}000{,}000 \times \$0.2 = \$30{,}000{,}000$

94 We calculate sales per region using data available at: https://www.statista.com/outlook/cmo/consumer-electronics/telephony/smartphones/worldwide#volume.

- As mentioned above, we estimate the total global licensing revenue for all HEVC licensors to be EUR 408 million in 2022. With Access Advance accounting for roughly two-thirds of the global HEVC landscape,[95] we estimate that the Access Advance generated licensing royalties of EUR 268 million in 2022. This implies that 38% of the licensing revenue of the pool comes from smartphones.

Via AAC

- The Via licensing AAC pool royalty rates follow a tiered royalty structure based on unit sales. There is no enterprise royalty cap.

Table 15: Via AAC royalty structure

Units (Millions)		Royalty Rate per Unit ($)
From unit number	To unit number	
0	0.5	0.98
0.5	1	0.78
1	2	0.68
2	5	0.45
5	10	0.42
10	20	0.22
20	50	0.2
50	75	0.15
75	>75	0.1

Source: https://www.via-corp.com/licensing/aac/license-fees/

- Based on the royalty structure and the list of licensees within the Via AAC pool, we estimate total smartphone royalties as shown below:

Table 16: Via AAC calculated smartphone royalties (2022)

Smartphone Producer	Sales (million units)	Licensee of Pool	Royalties Paid (€ million)
Samsung	260	Yes	34
Apple	225	Yes	30
Sony	3	Yes	9
Google	3	Yes	9

95 Access Advance, HEVC Worldwide Essential Patents Landscape, July 2022 Status of HEVC licensing – Patent Owners/Patent Count.

Lenovo	31	Yes	12
Total	**-**	**-**	**94**
Total (Minus licensors already documented)	**-**	**-**	**88**

Source: CRA calculations based on pool royalty rates and sales of major smartphone licensees within the pool. Licensee list available at https://www.via-corp.com/licensing/aac/licensees/ Conversion of royalties in USD to EUR with ECB's annual average exchange in 2022.

- To remove instances of double counting, we remove royalties attributable to licensors already separately identified in our analysis, namely Philips. Assuming that each of the 15 Via AAC licensors is entitled to the same royalty revenue from the pool, we subtract around 13% (=2/15) from the estimated total pool revenues.
- We estimate the total global licensing revenue for Via's AAC pool to be EUR 174 million in 2022. Starting with the total video device sales (2.6 billion units), we assume that 50% of device sales are licensed – to which the weighted average licence fee per unit (USD 0.16) applies. Similar to the above, we subtract around 7% to account for double counting of Philips. This implies that around half of the licensing revenue comes from smartphones.